CONTRACT AND SPECIFICATIONS

FOR

ENVIRONMENTAL OFFICE RTU REPLACEMENT

CITY OF HASTINGS

HASTINGS, NEBRASKA

Contract No. HU 2024-86

Sealed Proposals Will Be Opened Promptly At
1:30 PM, Wednesday, November 6, 2024

Bid Submitted By: _____

HASTINGS
UTILITIES

THIS BID DOCUMENT MUST BE SUBMITTED WITH BID

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CONTRACT AND SPECIFICATIONS
FOR
ENVIRONMENTAL OFFICE RTU REPLACEMENT
FOR
CITY OF HASTINGS
HASTINGS, NEBRASKA

Contract No. HU 2024-86

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II. CONTRACT FORMS

III. TECHNICAL SPECIFICATIONS

ADVERTISEMENT FOR BIDS

The City of Hastings, Nebraska, will receive bids for: **Environmental Office RTU Replacement HU 2024-86** until 1:30 p.m. at the City of Hastings, 1228 N Denver Ave., Hastings, Nebraska, on **Wednesday, November 6, 2024,** at which time and place all bids will be publicly opened and read aloud. **Brief description of project:** Provide materials and labor for mechanical and electrical upgrades to the Environmental office HVAC system**.** If you plan on bidding and are not already on our approved bidders list for this project, you are REQUIRED to fill out the Plan Holders Submittal Form that is located on the City website: https://www.cityofhastings.org/bids/.

The Contract Documents, including plans and specifications, are on file at the City of Hastings Offices, 1228 N Denver Avenue, Hastings, Nebraska 68901. Copies of the plans and specifications in electronic (PDF) format may be obtained by visiting the City of Hastings Website: www.cityofhastings.org/bids. A paper copy is available for $75.00, plus sales tax ($5.25), plus shipping.

Each bid shall be accompanied by a certified check, drawn on a solvent bank in the State of Nebraska, or a bid bond in an amount of not less than five percent (5%) of the total bid of all contract construction costs, made payable to the City Treasurer of the City of Hastings, Nebraska, as security that the bidder to whom the contract may be awarded will enter into a contract to build all the improvements in accordance with this notice and give bond in the sum hereinafter provided for the construction of improvements.

No bid shall be withdrawn after opening of bids without the consent of the City of Hastings, Nebraska, for a period of sixty (60) days after scheduled time of closing bids.

Time is of the essence in this contract. In evaluating bid(s) received, the City will consider the timelines of completion of prior construction contracts, existing workload of bidders and available manpower that bidder commits to the project.

The successful bidder will be required to furnish a Performance and Payment Bond in the sum of the full amount of the Contract within ten (10) days of the date of award. No additional time will be allowed the Contractor for providing the Performance and Payment Bond.

DATED AT HASTINGS, NEBRASKA, this 17th day of October 2024.

_____

Kimberly S Jacobitz, City Clerk

For City Clerk: Publish and Attach two (2) Proofs of Publication:

October 22, 2024
October 29, 2024

INSTRUCTIONS TO BIDDERS

All proposal information, including any unit price fill in sheets or other required information, shall be submitted on the proposal forms hereto attached. Copies of addenda, if any, shall be signed and attached. City of Hastings does NOT accept faxed or emailed bid returns.

Bidders shall inform themselves of all relevant matters, and, if awarded the contract, shall not be allowed any extra compensation by reason of any matter or thing concerning which such Bidder might not have fully informed themselves, prior to the bidding.

The Bidder bidding on the Specifications herein, who has exceptions to those called for in the Specifications, must so state in the space provided below and/or attach a letter explaining in detail the exceptions taken to those required in the Specifications. This letter of explanation shall become a part of the bid and shall be attached hereto. Failure by the Bidder to outline his exceptions will require the successful Bidder to comply with these Specifications.

EXCEPTIONS TO SPECIFICATIONS:

_____

_____

_____

_____

_____

The Purchaser will not assume obligations resulting from losses or damages until acceptance of the equipment.

Checks of unsuccessful Bidders will be returned when their bids have been rejected and they will not be retained in excess of sixty (60) days from the date bids are opened. The check of the successful Bidder will be retained until the contract is awarded. Should the successful Bidder fail to perform as the Proposal and Specifications indicate, the City may use the check as liquidated damages within fifteen (15) days after written notice is given to the party who submitted the successful bid.

If any person contemplating submitting a bid for this contract is in doubt as to the true meaning of any part of the Specifications or other proposed contract documents, he may submit to Purchaser a written request for an interpretation thereof. The person submitting the request will be responsible for its prompt delivery. Any interpretation of the proposed documents will be made only by addendum duly issued or delivered to each person receiving a set of such documents. The Purchaser will not be responsible for any other explanation or interpretation of the proposed documents.

All addendums must be signed and attached to bid documents.

IF YOU HAVE QUESTIONS OR NEED HELP ON THESE SPECIFICATIONS

CONTRACT NO: HU 2024-86

ENVIRONMENTAL OFFICE RTU REPLACEMENT

PLEASE CONTACT ANY OF THE FOLLOWING:

PROJECT QUESTIONS

Carson Moritz
Mechanical Engineer
Direct Line: 402-462-3678
Email: bidquestions@cityofhastings.org
cmoritz@cityofhastings.org

GENERAL QUESTIONS OR REQUESTS

Renae Griess
Administrative Assistant – Engineering Dept, City of Hastings
Ph# 402-462-3665
Fax# 402-462-3666
Email: bidquestions@cityofhastings.org

HASTINGS UTILITIES

IMPORTANT SUBMITTAL INSTRUCTIONS

ON HOW TO SUBMIT YOUR BID
FOR
CITY OF HASTINGS
ENVIRONMENTAL OFFICE RTU REPLACEMENT
Contract No. HU 2024-86

Your bid MUST be returned by means of hand delivery, USPS, Fed-X, UPS, or other carrier. City of Hastings DOES NOT ACCEPT bids that are faxed or emailed.

ALL the following documents are TO BE SUBMITTED in your bid packet, whether you received your bid invitation electronically, on a CD, DVD, or a HARD COPY by means of hand delivery or the mail carrier service.

More than one bid can be submitted by a supplier for alternate designs or technologies. Each bid shall be supplied in a separate envelope and contain the following documents.

1. **Cover sheet with your company's name filled in**
2. **ALL addendums received – must be acknowledged and signed**
3. **Bid Bond**
4. **If Exceptions, Instructions to Bidders with any exceptions listed**
5. **Proposal Page(s)**

FAILURE TO RETURN REQUIRED BID DOCUMENTS

COULD SUBJECT YOUR BID PROPOSAL TO BE REJECTED

IMPORTANT MAILING (OR HAND DELIVERY) INSTRUCTIONS

Please address your return envelope as shown in the example below. All bids must be sealed in a properly marked envelope.

To hand deliver please drop off between the hours of 8am – noon and 1pm – 5pm Monday-Friday.

Your Return Address

City of Hastings
Attn: Renae Griess
1228 N Denver Avenue
Hastings, NE 68901

This Information MUST BE typed or written in the lower left hand corner of return envelope
OR SIMPLY CUT OUT AND TAPE ON YOUR RETURN ENVELOPE

✂ ✂ ✂ ✂

BID DOCUMENTS ENCLOSED
ATTN: Renae Griess, Administrative Assistant
Contract No: HU 2024-86
Environmental Office RTU Replacement
Bid Opens: Wednesday, November 6, 2024 @ 1:30 pm

If returning Fed-X or similar carrier, please enclose the bid in an "inner" envelope which is sealed. Please make sure BOTH envelopes are properly marked on the OUTSIDE OF THE ENVELOPE as shown in the example above.

One bid per envelope. Bid submittal via email is not allowed. Bids must be checked in to the City of Hastings prior to 1:30 pm deadline.

PROPOSAL FOR

ENVIRONMENTAL OFFICE RTU REPLACEMENT

Contract No. HU 2024-86

TO: City of Hastings
1228 N. Denver Ave
Hastings, NE 68901

Bid Opening: Nov. 6, 2024 (Wednesday)
SEALED BIDS MUST BE RECEIVED BY 1:30 P.M. AND WILL BE OPENED PROMPTLY AT THAT TIME

We, the undersigned, being familiar with all parts of these documents, being Notice to Bidders, Bid Proposal Price Sheets, Contract Document Forms, Plans and Specifications, Affidavit, and all other parts of this document, do herein submit our proposal to **replace the NDS Environmental Office RTU and upgrade associated electrical,** for the following price, **including 7% Nebraska Sales Tax.** The labor portion is not subject to sales tax; however, the material portion is taxed accordingly. See following tax rules and regulation language.

Item #	Qty		Description	Unit Price	Total
1	1	EA	RTU Replacement and Electrical Upgrade		
TOTAL					
					$
In Words					

For purposes of sales/use tax, this project falls under Nebraska Sales and Use Tax Regulation 1-017 for Contractors. By definition, a contractor is "any person who repairs property annexed to, or who annexes property to, real estate, including leased property, by attaching building materials to the annexed property or improvement being built or repaired, or who arranges for annexation of property." Please refer to www.revenue.nebraska.gov/salestax.html for additional information.

For calculating this proposal:

- All contractors are to include sales/use tax on materials in the bidder's prices, if applicable.
- **Option 1 contractors must separately state materials, sales tax, labor, and other charges on all invoices for the project. Any invoices submitted that do not include this required breakdown of the charges will not be accepted for payment. (This requirement does not apply to Option 2 or 3 contractors.)**
- The sales/use tax rate on building materials is 7.0% for projects within Hastings' city limits and 5.5% for projects outside of city limits.
- Contractor labor charges for this proposal are not subject to sales/use tax per the Nebraska Department of Revenue Notice to Contractors effective October 1, 2007.
- In submitting this bid, the bidder certifies that he will comply with all applicable laws, ordinances, and codes of the City of Hastings and the State of Nebraska.
- For this project, Contractor will supply all materials.

PROPOSAL FOR
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What contractor option have you registered with the Nebraska Department of Labor (must select one)? Please refer to https://dol.nebraska.gov for additional information.

Option 1 _____

Option 2 _____

Option 3 _____

Is Nebraska Sales/Use Tax included in the above prices.

Yes _____ No _____

(ALL COSTS TO INCLUDE CITY AND STATE SALES TAX)

As noted in the proposal sheet one contract will be awarded for the sum total of all Bid Sections.

Exceptions: No ☐ Yes ☐ (If yes, list on ***"Instructions to Bidders"*** page)

Any modification of bid proposal will be considered non-conformance of the bid. All exceptions to the proposal shall be noted as an exception to the bid.

City of Hastings may at its own discretion delete any project area and / or component prior to award of contract.

In submitting this proposal, it is further understood that the City of Hastings reserves the right to reject any or all proposals and may waive any informalities and may accept the proposal which best suits its needs. It is further understood that this proposal may not be withdrawn for a period of sixty days (60) days after bids are opened.

All proposals shall have original signatures. Electronic time-stamped signatures will be acceptable. Photocopied or printed versions of bid bonds will be accepted without original signatures, however a hardcopy with original signatures must be received by City of Hastings within 5 business days.

PROPOSAL FOR
ENVIRONMENTAL OFFICE RTU REPLACEMENT
Contract No. HU 2024-86

OFFICIAL NAME & ADDRESS

Firm Name	Signature
Address	Typed or Printed Name
City, State, Zip	Title
Phone No.	Date
Fax No.	Email Address

ALL BIDS MUST BE CHECKED IN TO THE CITY OF HASTINGS PRIOR TO 1:30 PM DEADLINE

THIS BID DOCUMENT MUST BE SUBMITTED WITH BID

AGREEMENT

THIS AGREEMENT, made and entered into this day of 2024, by and between the City of Hastings, Party of the First Part, hereinafter called the "Purchaser" or "City", and a of (town) in the State of , Party of the Second Part, hereinafter called the "Contractor".

WITNESSETH: THAT,

WHEREAS: The Purchaser has caused the necessary contract documents to be prepared for defining material, equipment, and/or labor to be supplied to the City of Hastings and delivered complete as specified in the accompanying contract documents.

WHEREAS: The Purchaser has advertised for bids from Contractors, has received said bids, analyzed same and duly awarded a contract to the "Contractor", "Party of the Second Part", for material, equipment, and/or labor as hereinafter set forth and as stated more in detail in the Proposal and related contract documents to wit; Notice to Bidders, Instructions to Bidders, Specifications; all of which documents are attached hereto and made a part of this Contract.

NOW, THEREFORE: It is hereby agreed that for the sum of . ($)

to be paid by the Purchaser, within Thirty (30) days after the acceptance of material, equipment, and/or labor by the Purchaser, to the Contractor, the Contractor agrees to furnish all materials, equipment, and/or labor as required by the accompanying specifications, and the aforesaid contract documents, for **Environmental Office RTU Replacement HU 2024-86.**

All materials, equipment, and/or labor shall be in accordance with the accompanying contract documents and specifications which are as much a part of this Agreement as if repeated verbatim herein.

It is further agreed that the Contractor will start work promptly, furnish the necessary drawings promptly and complete the work in the number of days set forth in the Proposal.

AGREEMENT

IN WITNESS WHEREOF: The Parties of the First and Second Parts have hereto set their hands and seals on the day and year above written.

CITY OF HASTINGS
Party of the First Part

By: _____

Date: _____

ATTEST:

_____
City Clerk

CONTRACTOR
Party of the Second Part

SEAL

_____

By: _____

Title: _____

Date: _____

APPROVED TO FORM:

_____
City Attorney

Note: If executed by one other than President, Partner or the individual Owner, a Power-of-Attorney authorizing execution should accompany this Contract.

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS:

That we, the undersigned, _____,
as principal, and _____,
a corporation organized and existing under the laws of the State of _____,
and duly authorized to transact business in the State of Nebraska, as surety are held and firmly bound unto the CITY OF HASTINGS, NEBRASKA, a municipal corporation organized and existing under the laws of the State of Nebraska, hereinafter referred to as CITY, in the penal sum of _____ Dollars ($_____),
lawful money of the United States, for the payment of which will and truly be made, we the said principal and the said surety do hereby bind ourselves, our heirs, executors, administrators and assigns, jointly and severally, by these presents as follows:

The condition of this obligation is such that, whereas the principal, by an instrument in writing attached hereto and bearing the date of _____, 20____, has agreed with the CITY to do all work necessary and to furnish all labor, materials, supplies, tools and equipment to

_____

_____

_____

as specified thereby and in the specifications, proposals and contract forming the Contract Documents attached thereto and made a part hereof:

NOW THEREFORE, if the principal shall well and truly in good, sufficient and in a workmanlike manner, and to the satisfaction of the CITY perform and complete the work required, and shall defend, indemnify and save harmless the CITY against all damages, claims, demands, expenses and charges of every kind (including claims of patent infringement) arising from any act, omission or neglect of said principal, his agents, servants or employees, with relation to said work, and shall pay all costs, charges, rentals and expenses for labor, materials, supplies and equipment and deliver the said improvement to the CITY completed and ready for operation and free from all encumbrances or claims for labor, materials or otherwise, and shall pay all other expenses lawfully chargeable to the CITY, and this bond shall also be for the use and benefit of all persons who may perform any work or labor or furnish any material in the execution of said Contract and may be

sued on thereby in the name of any such party claiming the benefit hereof, then this obligation shall be void, otherwise the same shall remain in full force and effect. This obligation shall be in full force and effect for the full guarantee period provided in the specifications contained herein.

PROVIDED FURTHER, that said surety for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or the work to be performed thereunder or the specifications accompanying the same shall in any way affect its obligation on this bond, and it does hereby waive notice of any change, extension of time, alteration or addition to terms of the Contract, to the work or to the specifications.

PROVIDED FURTHER, that if the principal of his, their or its subcontractor or subcontractors fail to duly pay for any labor, materials team, hire sustenance, provisions, provender or any other supplies or materials used or consumed by such contractor of his, their or its subcontractors in performance of the work contracted to be done, the surety will pay the same in any amount not exceeding the sum specified in the bond together with interest as provided by law.

IT WITNESS WHEREOF, said principal and surety have hereunto set their hands and seals at _____ this _____ day of _____, 20____,

This Bond is executed in triplicate counterparts.

_____
Principal

_____
Street Address

(SEAL)

_____
Witness

_____
City, State, Zip

_____
Name of Person Executing

_____
Surety

ATTEST:

_____
_____

By: _____
Title: _____

A F F I D A V I T

State of Nebraska)
) ss.
County of Adams)

I _____ , _____
Name Title

of _____
Firm Name

do hereby certify that all subcontractors, vendors, persons or firms who have furnished labor or material for the _____

_____

_____

have been fully paid and that all taxes have been paid.

_____
Signature

_____
Date

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

_____
Notary Public

My commission expires _____.

A signed and notarized copy of affidavit must be in City of Hastings file before final payment may be made.

Copy of forms will be supplied by City of Hastings prior to final payment.

SECTION 1 - GENERAL CONDITIONS

GENERAL CONDITIONS

GC.1 Contract Documents

It is understood and agreed that the Notice to Bidders, Instructions to Bidders, Proposal, Proposal Data, Contract Agreement, Performance Bond, Payment Bond, General Conditions, Special Conditions, Specifications, Drawings, Addenda, and Change Orders issued by the Purchaser or the Engineer, and specifications and engineering data furnished by the Contractor and accepted by the Purchaser, are each included in this Contract and the work shall be done in accordance therewith.

GC.2 Definitions

Words, phrases, or other expressions used in these contract documents shall have meanings as follows.

1. "Contract" or "contract documents" shall include the items enumerated above under CONTRACT DOCUMENTS.
2. "Purchaser" shall mean the City of Hastings named and designated in the Contract Agreement as "Party of the First Part," and their duly authorized agents. All notices, letters, and other communication directed to the Purchaser shall be addressed and delivered to:

   City of Hastings – Engineering Department
   Attention: Carson Moritz, Mechanical Engineer
   1228 N Denver Ave
   Hastings, Nebraska 68901

   Or, by email to cmoritz@cityofhastings.org

3. "Contractor" shall mean the corporation, company, partnership, firm or individual named and designated in the Contract Agreement as the "Party of the Second Part," who has entered into this Contract for the performance of the work covered thereby, and its, his, or their duly authorized representatives.
4. "Subcontractor" shall mean and refer only to a corporation, partnership, or individual having a direct contract with the Contractor for performing work covered by these contract documents.
5. "Engineer" shall also refer to City of Hastings as the purchaser.
6. "Date of contract," or equivalent words, shall mean the date written in the first paragraph of the Contract Agreement.
7. "Day" or "days," unless herein otherwise expressly defined, shall mean a calendar day or days of 24 hours each.
8. "The work" shall mean the equipment, supplies, materials, labor, and services to be furnished under the contract and the carrying out of all obligations imposed by the contract documents.
9. "Drawings" or "plans" shall mean all (a) drawings furnished by the Purchaser as a basis for proposals, (b) supplementary drawings furnished

by the Purchaser to clarify and to define in greater detail the intent of the contract drawings and specifications, (c) drawings submitted by the successful bidder with his proposal, provided such drawings are acceptable to the Purchaser, (d) drawings furnished by the Purchaser to the Contractor during the progress of the work, and (e) engineering data and drawings submitted by the Contractor during the progress of the work, provided such drawings are acceptable to the Engineer.

10. Whenever in these contract documents the words "as ordered," "as directed," "as required," "as permitted," "as allowed," or words or phrases of like import are used, it shall be understood that the order, direction, requirement, permission, or allowance of the Purchaser or Engineer is intended only to the extent of judging compliance with the terms of the contract; none of these terms shall imply that the Purchaser or the Engineer has any authority or responsibility for supervision of the Contractor's forces or construction operations, such supervision and the sole responsibility therefor being strictly reserved for the Contractor.

11. Similarly, the words "approved," "reasonable," "suitable," "acceptable," "proper," "satisfactory," or words of like effect and import, unless otherwise particularly specified herein, shall mean approved, reasonable, suitable, acceptable, proper, or satisfactory in the judgment of the Purchaser or Engineer, to the extent provided in (10) above.

12. Whenever in these contract documents the expression "it is understood and agreed" or an expression of like import is used, such expression means the mutual understanding and agreement of the parties executing the Contract Agreement.

13. "Official acceptance" shall mean the Purchaser's written acceptance of all work performed under this Contract, based on the Engineer's final inspection and issuance of a final payment certificate.

14. “Project completion” shall mean that the Air Heater is ready for operation and all old material has been disposed of per the specification.

15. “Final Acceptance” shall mean that all work has been completed in accordance with these specifications, the project has been walked down, punch list items have been completed, and Purchaser is ready to accept the Work as complete.

16. “Stop Work Order” shall mean that the Purchaser will provide a written order to the Contractor requiring the Contractor to stop all, or any part of, the work called for by this Contract, for a time defined by the order. The order shall specify the reasoning for the suspended work, which may include, but are not limited to, engineering considerations, changes to the project scope, safety or environmental concerns, or other issues detrimental to the project. Upon receipt of the order, the Contractor shall immediately comply with its terms and take all reasonable steps to minimize the incurrence of costs allocable to the work covered by the order. As soon as practical, the Purchaser and Contractor shall discuss the

impacted activities, schedule, materials, labor, and equipment. If applicable, Purchaser and Contractor will seek to negotiate an equitable adjustment in the schedule, Contract price, or both, and the contract shall be modified, or a change order issued, as necessary. Upon any agreement and finalization of commercial conditions, Purchaser to provide written order to cancel the stop work order.

GC.3 Execution of the Contract

Once the bids have been evaluated, the Purchaser will electronically submit the Contract Agreement to the Contractor. The Contractor shall sign the Contract Agreement and return to Purchaser for the final approval process. Upon final approvals, the Contract Agreement will be signed by the Purchaser and electronically returned to the Contractor. Contractor shall then mail one hardcopy of required bonds, one electronic or hardcopy of insurance documents, and one electronic or hardcopy of power of attorney forms to the Purchaser. The date of contract on the bond forms and power of attorney forms shall match the date provided on the Contract Agreement by the Purchaser.

The Purchaser will review the final documents and electronically send a final conformed contract to the Contractor.

GC.4 Legal Addresses

The business address of the Contractor listed in the Proposal is hereby designated as the place to which all notices, letters, and other communication to the Contractor will be mailed or delivered. The address of the Purchaser appearing in section GC.2 is hereby designated as the place to which all notices, letters, and other communication to the Purchaser shall be mailed or delivered. Either party may change his address at any time by an instrument in writing delivered to the Engineer and to the other party.

GC.5 Scope and Intent of Contract Documents

The various parts of the contract documents are intended to supplement but not necessarily duplicate each other. Any work exhibited in one part and not in another shall be executed as if it had been set forth in all parts, so that the work will be performed according to the complete design as determined by the Engineer.

Should anything necessary for a clear understanding of the work be omitted from the contract documents, or should the requirements appear to be in conflict, the Contractor shall secure written instructions from the Engineer before proceeding with the work affected thereby. It is understood and agreed that the work shall be performed according to the true intent of the contract documents.

GC.6 Independent Contractor

The relationship of the Contractor to the Purchaser shall be that of an independent contractor.

GC.7 Assignment

The Contractor shall not assign the work, or any part thereof, without the previous written consent of the Purchaser, nor shall he assign, by power of attorney or otherwise, any of the money payable under this Contract unless written consent of the Purchaser has been obtained. No right under this Contract, nor claim for any money due or to become due

hereunder shall be asserted against the Purchaser, or persons acting for the Purchaser, by reason of any so-called assignment of this Contract or any part thereof, unless such assignment has been authorized by the written consent of the Purchaser. In case the Contractor is permitted to assign moneys due or to become due under this Contract, the instrument of assignment shall contain a clause subordinating the claim of the assignee to all prior liens for services rendered or materials supplied for the performance of the work.

GC.8 Oral Statements

It is understood and agreed that the written terms and provisions of this agreement shall supersede all oral statements of representatives of the Purchaser, and oral statements shall not be effective or be construed as being a part of this Contract.

GC.9 Reference Standards

Reference to the standards of any technical society, organization, or association, or to codes of local or state authorities, shall mean the latest standard, code, specification, or tentative standard adopted and published at the date of taking bids, unless specifically stated otherwise.

GC.10 Source of Materials

To the extent possible, materials, and equipment (including components thereof) furnished under these specifications shall be produced, processed, manufactured, and assembled within the United States of America. Substitution of foreign materials for domestic materials will not be permitted unless such substitution is clearly stated in the Proposal and accepted by the Purchaser.

GC.11 Contractor to Check Drawings and Lists

The Contractor shall check all dimensions, elevations, and quantities indicated on the drawings and lists furnished to him by the Engineer. The Contractor shall notify the Engineer of any discrepancy between the drawings and the conditions at the site, or any error or omission in the drawings, or in the layout as given by stakes, points, or instructions, which he may discover in the course of the work. The Contractor will not be allowed to take advantage of any error or omission in the drawings or other contract documents that a reasonable inspection of them by Contractor would reveal. Full instructions will be furnished by the Engineer should such error or omission be discovered, and the Contractor shall carry out such instructions as if originally specified.

GC.12 Figured Dimensions to Govern

Dimensions and elevations indicated on the drawings shall be accurately followed even though different from scaled measurements. No work indicated on the drawings, the dimensions of which are not indicated, shall be executed until necessary dimensions have been obtained from the Engineer.

GC.13 No Waiver of Rights

Neither the inspection by the Purchaser or Engineer or any of their officials, employees, or agents, nor any order by the Purchaser or Engineer for payment of money, or any payment for, or acceptance of, the whole or any part of the work by the Purchaser or Engineer, nor any extension of time, nor any possession taken by the Purchaser or its employees, shall operate

as a waiver of any provision of this Contract, or of any power herein reserved to the Purchaser, or any right to damages herein provided, nor shall any waiver of any breach in this Contract be held to be a waiver of any other or subsequent breach.

GC.14 Authority of the Engineer

To prevent delays and disputes, and to discourage litigation, it is agreed by the parties to this Contract that the Engineer shall determine the quantities of work which are to be paid for under the contract and shall resolve all questions in relation to the work.

If, in the opinion of the Contractor or the Purchaser, a decision made by the Engineer is not in accordance with the meaning and intent of the contract, either party may file with the Engineer and the other party to the contract, within 30 days after receipt of the decision, a written objection to the decision. Failure to file an objection within the allotted time will be considered acceptance of the Engineer's decision and the decision shall become final and conclusive.

The Engineer's decision and the filing of the written objection thereto shall be a condition precedent to the right to request arbitration or to start action in court.

It is the intent of this agreement that there shall be no delay in the execution of the work and the decision of the Engineer as rendered shall be promptly observed.

GC.15 Engineering Inspection

The Purchaser may appoint (either directly or through the Engineer) such inspectors as the Purchaser deems proper to inspect the work for compliance with the contract documents. The Contractor shall furnish all reasonable assistance required by the Engineer, or inspectors, for the proper inspection of the work. Should the Contractor object to any interpretation of the contract by an inspector, the Contractor may make written appeal to the Engineer for a decision.

Inspectors shall have the authority to reject work which is unsatisfactory, faulty, or defective or does not conform to the requirements of the contract documents. Inspection shall not relieve the Contractor from any obligation to construct the work strictly in accordance with the contract documents.

Upon the failure of the Contractor or its Subcontractors to comply with any of the requirements of this Contract (but not limited to quality or safety), the Purchaser shall have the authority to stop any portion of the work affected by such failure until such failure is remedied. If the Purchaser issues a Stop Work Order, the Purchaser shall not be liable for any costs or expenses claimed by Contractor arising out of such issuance. The construction schedule shall not be delayed or extended as a result of the Purchaser’s issuance of a Stop Work Order.

GC.16 Contractor Default

If the work to be done under this Contract is abandoned by the Contractor; or if this Contract is assigned by him without the written consent of the Purchaser; or if the Contractor is adjudged bankrupt; or if a general assignment of his assets is made for the benefit of his

creditors; or if a receiver is appointed for the Contractor or any of his property; of if at any time the Engineer certifies in writing to the Purchaser that the performance of the work under this Contract is being unnecessarily delayed, that the Contractor is violating any of the conditions of this Contract, or that he is executing the same in bad faith or otherwise not in accordance with the terms of said contract; or if the work is not substantially completed within the time named for its completion or within the time to which such completion date may be extended; then the Purchaser may serve written notice upon the Contractor and his surety of the Purchaser's intention to terminate this Contract. Unless within 5 days after the serving of such notice, a satisfactory arrangement is made for continuance, this Contract shall terminate. In the event of such termination, the surety shall have the right to take over and complete the work, provided that if the surety does not commence performance within 30 days, the Purchaser may take over and prosecute the work to completion, by contract or otherwise. The Contractor and his surety shall be liable to the Purchaser for all excess cost sustained by the Purchaser by reason of such prosecution and completion. The Purchaser may take possession of, and utilize in completing the work, all materials, equipment, tools, and plant on the site of the work.

GC.17 Beginning, Progress, and Completion of the Work

The time of completion is a basic consideration of this Contract. Unless otherwise specified in these contract documents or advised by written order of the Purchaser, the Contractor shall begin work within 10 days after the date of contract. The work shall be prosecuted to completion in accordance with the specified schedule, subject to adjustment as provided in these contract documents.

A detailed construction schedule shall be prepared by the Contractor and submitted to the Purchaser for review. The schedule shall contain the various activities required to perform the work and the dates the activities will be started and completed in order to complete the work in accordance with the specified schedule requirements. The Contractor is responsible for determining the sequence and time estimates of the detailed construction activities. However, the Purchaser reserves the right to require the Contractor to modify any portion of the schedule the Purchaser determines to be impracticable or unreasonable; as required to coordinate the Contractor's activities with those of other contractors, if any, engaged in work for the Purchaser on the site; to avoid undue interference with the Purchaser's operations; and to assure completion of the work by the date or dates stipulated. Upon acceptance by the Purchaser of the Contractor's detailed construction schedule, the Contractor will be responsible for maintaining such schedule.

If at any time the Contractor's work is behind schedule, he shall immediately put into effect definite procedures for getting the work back on schedule. The procedures shall be subject to review and modification by the Purchaser.

GC.18 Hindrances and Delays

The Contractor expressly agrees that in undertaking to complete the work within the time specified, he has made allowances for all hindrances and delays which might usually be expected to occur in performing the work. No claims shall be made by the Contractor for such hindrances and delays.

If the Contractor experiences hindrances and delays which, in his opinion, are not usually to be expected in the performance of the work and which affect the performance of the work, he may request a change in the contract. Such hindrances and delays may include, but not be limited to, acts or failure to act by the Purchaser or other contractors employed by the Purchaser, fires, floods, labor disputes, epidemics, or acts of God. Such hindrances and delays shall not include rain, snow, or other non-severe inclement weather. Claims by the Contractor for any change in the contract due to such hindrances and delays shall be made in accordance with the requirements of Article GC.22, CHANGES TO THE CONTRACT. The Contractor shall use all reasonable means to minimize the extent of the delay.

GC.19 Suspension of Work

The Purchaser reserves the right to suspend and reinstate execution of the whole or any part of the work without invalidating the provisions of the contract. Suspension or reinstatement of the work will be by written notice to the Contractor from the Purchaser.

Suspension of work shall not automatically entitle the Contractor to additional compensation or a change in the contract time; however, the Contractor will be reimbursed for real and unavoidable direct costs incurred by him as a result of such suspension and/or the contract will be extended as required to compensate for any delay due to such suspension. Claims by the Contractor for change of contract time or an adjustment of the contract price, due to work suspensions ordered by the Purchaser shall be made in accordance with the requirements of Article GC.22, CHANGES TO THE CONTRACT. The Contractor shall use all reasonable means to minimize the consequences of such suspension.

GC.20 Cancellation of Work

The Purchaser reserves the right to cancel the unshipped portion of the work by giving written notice to the Contractor. In the event of cancellation, the Purchaser will pay the Contractor reasonable and proper cancellation costs.

Cancellation of the work shall not constitute the basis for a claim for damages or loss of anticipated profits.

The Contractor shall, after consultation with the Purchaser, take all reasonable steps to minimize the costs related to cancellation. The Contractor shall provide the Purchaser with an accounting of costs claimed, including adequate supporting information, and the Purchaser may, at its expense, audit the claimed costs and supporting information.

GC.21 Modifications

The Contractor shall modify the work whenever so ordered by the Purchaser and such modifications shall not affect the validity of the contract. Modifications may involve changes in the amount of the work to be performed or changes in the contract time for which appropriate changes to the contract will be made.

Contract changes due to modifications shall be made in accordance with the requirements of Article GC.22, CHANGES TO THE CONTRACT.

GC.22 Changes to the Contract

The contract may be changed only by duly executed change orders issued by the Purchaser.

If, in the opinion of the Purchaser or the Contractor, any event or action by the other party justifies a change in the contract, either party shall initiate with the other party, within 5 days after such event or action, a request for a change to the contract. All documentation required to substantiate the proposed change shall be submitted within a minimum reasonable time after initiating the request for change. Upon the parties reaching agreement regarding the proposed change, the Purchaser will issue a written change order therefor.
Notwithstanding the foregoing provisions requiring duly authorized change orders, in the event agreement has been reached between authorized representatives of the parties regarding the change in the contract pending processing of such change order, the Contractor shall proceed with the work on the basis of written interim authorization from the Purchaser.

If the Contractor claims that any instruction, request, drawing, specifications, or other directive or action of the Purchaser or the Engineer constitutes a change in the contract, but has not been authorized as such by a change order in writing by the Purchaser, the Contractor shall immediately request a written interim authorization and proceed without delay to perform the work in accordance with such authorization. The Contractor shall provide written notice of the claim or dispute to the Engineer and the Purchaser within 5 days of the request for interim authorization. The Contractor's failure to give said written notice within the 5 day period shall constitute a waiver and relinquishment of any such claim or dispute. The Purchaser's written interim authorization shall not constitute approval of the claim for increased or decreased work, but shall be a condition precedent to the Contractor's right to receive payment for such work and to the Contractor's right to prosecute or maintain any proceeding to recover for such work.

GC.22.1 Contract Price Changes

The contract price may be changed due to modifications which involve extra work or decreased work; or due to work suspensions, hindrances, and delays over which the Contractor has no control. Claims for changes in the contract price shall conform to the requirements specified herein.

GC.22.1.1 Increased Price

If a change in the contract is required due to work suspensions or hindrances and delays, the contract price will be increased according to agreed lump sums, agreed acceleration costs, or other demonstrable costs submitted by the Contractor and substantiated to the satisfaction of the Purchaser.

If a change in the contract price is required due to a modification which increases the amount of the work, and the added work or any part thereof is of a type and character which can properly and fairly be classified under one or more unit price items of the contract, then the contract price will be increased according to the amount actually done and at the applicable unit price. Otherwise, such work shall be paid for as herein-after provided.

Contract price changes for modifications involving extra work will be based on agreed lump sums or on agreed unit prices whenever the Purchaser and the Contractor agree upon such

prices before the extra work is started; otherwise, payments for extra work will be based on actual direct cost plus the specified percentage allowance.

For the purpose of determining whether proposed extra work will be authorized, or for determining the payment method for extra work, the Contractor shall submit to the Engineer, upon request, a detailed cost estimate for proposed extra work. The estimate shall indicate itemized quantities and charges for all elements of direct cost. Charges for the Contractor's and subcontractor's extra profit, extra general superintendence, extra field office expense, and extra overheads shall be indicated as a percentage addition to the total estimated direct cost. Unless otherwise agreed upon by the Contractor and the Purchaser, such percentage additions shall be 15 percent for the extra work performed by the Contractor's own forces or 20 percent for extra work performed by a subcontractor.

When payment for extra work is based on actual direct cost, the Contractor will be paid the actual direct cost plus an allowance of 15 percent if the extra work is performed by the Contractor's own forces or 20 percent if the extra work is performed by a subcontractor. The allowance will be paid as full compensation for the Contractor's and sub-contractor's extra profit, extra general superintendence, extra field office expense, extra overheads, and all other elements of extra cost not defined herein as actual direct cost.

The actual direct cost shall include only those extra costs for labor and material expended in direct performance of the extra work and may include the following.

a. The actual payroll cost of all workmen such as laborers, mechanics, craftsmen, and foremen.

b. The Contractor's or subcontractor's net cost for materials and supplies.

c. The rental charge for vehicles and construction equipment.

d. The transportation charges for equipment.

e. The charges for extra power, fuel, lubricants, water, and special services.

f. The charges for extra payroll taxes, bond premiums, and insurance premiums.

The form in which actual direct cost records are kept, the construction methods, and the type and quantity of equipment used shall be acceptable to the Engineer.

Construction equipment which the Contractor has on the jobsite and which is of a type and size suitable for use in performing the extra work shall be used. The hourly rental charges for equipment shall not exceed 1/2 percent of the latest applicable monthly rental rates as published by Dataquest Incorporated in its "Rental Rate Blue Book" and shall apply to only the actual time the equipment is used in performing the extra work.

When extra work requires the use of equipment which the Contractor does not have on the jobsite, the Contractor shall obtain the concurrence of the Engineer before renting or otherwise acquiring additional equipment. The rental charges for the additional equipment shall not exceed the latest applicable "Rental Rate Blue Book" published rental rates.

GC.22.1.2 Decreased Price

If a change in the contract price is required due to a modification which decreases the amount of work, such decrease shall not constitute the basis for a claim for damages or anticipated profits on work affected by such decrease. Where the value of omitted work is not covered by applicable unit prices, the Engineer shall determine, on an equitable basis, the amount of:

a. Credit due the Purchaser for contract work deleted as a result of an authorized change,

b. Allowance to the Contractor for any actual loss incurred in connection with the purchase, delivery, and subsequent disposal of materials or equipment required for use on the work as planned and which could not be used in any part of the work as actually built, and

c. Any other adjustment of the contract amount where the method to be used in making such adjustment is not clearly defined in the contract documents.

Unless otherwise agreed upon by the Purchaser and the Contractor, the credit due the Purchaser for reductions in the amount of work to be done shall be the estimated direct cost of the deleted work plus an overhead allowance of the following.

- 10 percent of the estimated direct cost if the work was to have been done by the Contractor's own forces, or
- 15 percent of the estimated direct cost if the work was to have been done by a subcontractor.

Direct cost referred to above shall include the category of costs listed as actual direct costs, Items (a) to (f) inclusive of the article entitled Increased Price.

GC.22.2 Contract Time Changes

The contract time may be changed due to work modifications, hindrances and delays, and work suspensions over which the Contractor has no control.

Contract time will not be changed for delays caused by unfavorable weather or unsuitable ground conditions normally incident to the work, inadequate construction force, failure to place timely orders for equipment and materials, or other causes within the control of the Contractor.

GC.23 Step Dispute Resolution

In the event of any controversy, claim or dispute between the Parties arising out of or relating to this Agreement, including its enforcement, such controversy, claim or dispute, including disputes regarded as such by only one of the Parties, the Parties shall negotiate in good faith to resolve such dispute, including third party mediation, if the Parties so agree.

If no settlement is achieved, either Party may pursue a claim in a federal or state court with competent jurisdiction.

GC.24 Laws and Regulations

The Contractor shall observe and comply with all ordinances, laws, and regulations, and shall protect and indemnify the Purchaser and the Purchaser's officers and agents, including the Engineer, against any claim or liability arising from or based on any violation of the same.

GC.25 Taxes, Permits, and Licenses

The Contractor shall pay all sales, use, and other taxes that are lawfully assessed against the Purchaser or Contractor in connection with the work and shall obtain and pay for all required licenses, permits, and inspections.

The Contractor will be compensated for any increase in tax rates, license fees, and permit fees or any new taxes, licenses, or permits imposed after the date of the Proposal; provided, however, that this provision shall be limited to sales, use, and excise taxes assessed against the completed work and to licenses and permits required specifically for the proposed work.

GC.26 Patents

Royalties and fees for patents covering materials, articles, apparatus, devices, equipment, or processes used in the work shall be included in the contract amount. The Contractor shall satisfy all demands that may be made at any time for such royalties or fees and he shall be liable for any damages or claims for patent infringements. The Contractor shall, at his own cost and expense, defend all suits or proceedings that may be instituted against the Purchaser for alleged infringement of any patents involved in the work and, in case of an award of damages, the Contractor shall pay such award. Final payment to the Contractor by the Purchaser will not be made while any such suit or claim remains unsettled.

GC.27 Materials and Equipment

Unless specifically provided otherwise in each case, all materials and equipment furnished for permanent installation in the work shall conform to applicable standard specifications and shall be new, unused, and undamaged when installed or otherwise incorporated in the work. No such material or equipment shall be used by the Contractor for any purpose other than that intended or specified, unless such use is specifically authorized by the Purchaser in each case.

All required tests in connection with acceptance of source of materials shall be made at the Contractor's expense by a properly equipped laboratory of established reputation whose work and testing facilities are acceptable to the Purchaser. Any change in origin or method of preparation or manufacture of a material being routinely tested will require new tests. Reports of all tests shall be furnished to the Engineer or Purchaser in as many copies as required.

GC.28 Guarantee

The Contractor guarantees that the work herein contracted will be as specified and will be free from defects in design, workmanship, and materials. Contractor does not guarantee or warrant parts subject to normal wear and tear during operation. If within the guarantee period the work fails to meet the provisions of this guarantee, the Contractor shall promptly correct any defects, including nonconformance with the contract documents by adjustment, repair, or replacement of all defective parts or materials at the Contractor's option and expense, after consulting with the Purchaser on the proposed remedy plans.

Except as otherwise prescribed by the terms of any special guarantees required by the contract documents, the guarantee period shall begin on the date of final payment and shall end 12 months later.

The cost of all materials, parts, labor, transportation, supervision, special tools, and supplies required for replacement or repair of parts and for correction of defects shall be paid by the Contractor or by the surety.

This guarantee shall be extended to cover all repairs and replacements furnished under the guarantee and the period of the guarantee for each such repair or replacement shall be 1 year after correction of the defect except as otherwise prescribed by the terms of any special guarantees required by the contract documents.

The Contractor will be given an opportunity to confirm the existence of the defect, but he shall not delay the correction while making such determination.

If within 10 days after the Purchaser has notified the Contractor of a defect, failure, or abnormality in the work, the Contractor has not started to make the necessary repairs or adjustments, the Purchaser is hereby authorized to make the repairs or adjustments or to order the work to be done by a third party; the cost of the work to be paid by the Contractor.

In the event of an emergency where, in the judgment of the Purchaser, delay would cause serious loss or damage, repairs or adjustments may be made by the Purchaser or a third party chosen by the Purchaser without advance notice to the Contractor and the cost of the work shall be paid by the Contractor or by the surety.

GC.29 Contractor's Insurance Coverage

The Contractor shall not commence work under this Contract until Contractor has obtained all the insurance required under this article. Furthermore, the Contractor shall not allow any sub-contractor to commence work under this Contract until the sub-contractor has obtained the same insurance as is required of the Contractor. The sub-contractor alone shall be responsible for the sufficiency of its own insurance program.

GC.29.1 Certificates of Insurance

Certificates of Insurance acceptable to the Purchaser shall be filed with the Purchaser prior to commencement of the work. All insurance carried shall conform to the relevant provisions of the respective Project Documents and be with insurance companies which are rated "A, X" or better by Best's Insurance Guide, or other insurance companies of recognized responsibility satisfactory to the Purchaser.

GC.29.2 Proof of Carriage of Insurance.

Satisfactory certificates of insurance shall be filed with the Purchaser prior to starting any construction work on this contract. The parties agree that the requirements with respect to requirements to procure and maintain insurance under this Section is a material part of this Agreement.

GC.29.3 Additional Insureds

Insurance coverages furnished under this Contract, with the exception of Workers' Compensation and Employer's Liability, shall include the City of Hastings and their members, directors, officers, agents, and employees as named Additional Insureds on a primary and noncontributory basis, and shall include Products and completed operations with respect to the activities of the Contractor and shall be maintained for the full duration of the project including for a period after completion to include the statute of repose.

Notwithstanding any other provision of these policies, the insurance afforded shall apply separately to each insured, with respect to any claim, suit, or judgment made or brought by or for any other insured, as though a separate policy had been issued to each, except the insurer's liability shall not be increased beyond the amount or amounts for which the insurer would have been liable had only one insured been named.

The Purchaser shall not by reason of their inclusion under these policies incur liability to the insurance carrier for payment of premium for these policies.

GC.29.4 Waiver of Subrogation

To the extent permitted by applicable law, the Contractor and their sub-contractor shall require their insurance carriers, with respect to all insurance policies, to waive all rights of subrogation against the Purchaser their partners, directors, officers, agents, and employees.

GC.29.5 Workers' Compensation and Employer's Liability Insurance

The Contractor shall procure, and shall maintain during the life of this Contract, Workers' Compensation Insurance as required by workers' compensation laws of the State of Nebraska and also of the state in which the sub-contractor is domiciled.

The Contractor shall also be protected against claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of a workers' compensation law. The Employer's Liability Insurance shall contain the following limits of liability:

Bodily Injury by Accident	$500,000 each accident
Bodily Injury by Disease	$500,000 each employee
Bodily Injury by Disease	$500,000 policy limit

GC.29.6 General Liability Insurance

This insurance shall be written per project on an “occurrence” policy form, including coverage for premises/operations, products/completed operations, blanket contractual liability, independent contractors and personal injury, with no exclusions for explosion, sudden and accidental pollution or an absolute or total pollution exclusion, collapse and underground perils. The commercial general liability policy shall also include a severability of interest clause and a cross liability clause in the event more than one entity is “named insured” or “named additional insured” under the liability policy.

Limits of Insurance shall be as follows:

Each Occurrence Limit	$1,000,000

Products/Completed Operations	$2,000,000
General Aggregate Limit	$2,000,000
Personal and Advertising Injury	$1,000,000

GC.29.7 Automobile Liability Insurance

This insurance shall be written under a Business Auto Policy and shall protect the Contractor and Additional Insureds against claims arising from injuries to members of the public or damage to property of others arising from the use of automobiles whether such automobiles are owned, non-owned, or hired. Automobile insurance shall include Motor Carrier Endorsement Act MCS 90 and transportation pollution coverage if applicable. If work is being done near a railroad track, the 50' railroad right of way exclusion must be deleted.

Limit of Liability	$1,000,000 each accident

GC.29.8 Umbrella Liability Policy

This insurance shall protect the Contractor and the Additional Insureds against all claims in excess of the limits provided under the employer's liability, automobile liability, and general liability policies. The liability limits of the umbrella liability policy shall be not less than $5,000,000 per occurrence. This policy shall be an "occurrence" type policy. However, Purchaser reserves the right to require higher limits with respect to each project.

GC.29.9 Pollution Liability – Not Applicable

GC.29.10 Riggers Liability – Applicable

Should work involve the moving, lifting, lowering, rigging or hoisting of property or equipment Contractor shall carry Rigger's Liability Insurance to insure against physical loss or damage to the property or equipment on a Replacement Cost Basis.

GC.29.11 Railroad Protective Liability – Not Applicable

GC.29.12 Professional Liability – Not Applicable

GC.29.13 Transportation Insurance – Not Applicable

GC.29.14 Property Insurance A.K.A. Builder's Risk - Not Applicable

GC.30 Indemnification

To the fullest extent permitted by laws and regulations, the Contractor shall defend, indemnify, and hold harmless the Purchaser, their officers, directors, members, consultants, agents, and employees from and against all claims, damages, losses, and expenses, direct, indirect, or consequential (including but not limited to fees and charges of engineers, architects, attorneys, and other professionals and court and arbitration costs) arising out of or resulting from the negligent, wrongful, or defective performance of the work by the Contractor, any sub-contractor, any person or organization directly or indirectly employed by any of them to perform or furnish any of the work, or anyone for whose acts any of them may be liable, regardless of whether or not it is caused in part by a party indemnified hereunder or arises by or is imposed by law and regulations regardless of the negligence of any such party.

In any and all claims against the Purchaser, or of any of their officers, directors, members, consultants, agents, or employees by any employee of the Contractor, any sub-contractor, any person or organization directly or indirectly employed by any of them to perform or furnish any of the work or anyone for whose acts any of them may be liable, this indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for the Contractor or any such sub-contractor or other person or organization under workers' or workmen's compensation acts, disability benefit acts, or other employee benefit acts, nor shall this indemnification obligation be limited in any way by any limitation on the amount or type of insurance coverage provided by the Purchaser, the Contractor, or any of their sub-contractors.

GC.31 Release of Liability

Acceptance by the Contractor of the last payment shall be a release to the Purchaser and every officer and agent thereof, from all claims and liability hereunder for anything done or furnished for, or relating to the work, or for any act or neglect of the Purchaser or of any person relating to or affecting the work.

GC.32 Claims for Labor and Materials

The Contractor shall indemnify and save harmless the Purchaser from all claims for labor and materials furnished under this Contract. When requested by the Purchaser, the Contractor shall submit satisfactory evidence that all persons, firms, or corporations who have done work or furnished materials under this Contract, for which the Purchaser may become legally liable, have been fully paid or satisfactorily secured. In case such evidence is not furnished or is not satisfactory, an amount will be retained from money due the Contractor which, in addition to any other sums that may be retained, will be sufficient, in the opinion of the Purchaser, to liquidate all such claims. Such sum will be retained until the claims as aforesaid are fully settled or satisfactorily secured.

Before final acceptance of the work by the Purchaser, the Contractor shall submit to the Engineer in duplicate a notarized affidavit stating that all subcontractors, vendors, persons, or firms who have furnished labor or materials for the work have been fully paid and that all taxes have been paid. If a performance bond has been executed, a statement from the surety shall also be submitted consenting to the making of the final payment.

GC.33 Final Inspection

When the work has been substantially completed and at a time mutually agreeable to the Purchaser and Contractor, the Purchaser will make a final inspection of the work as to the acceptability and completeness of the work.

GC.34 Payments and Retainage.

The City, at its discretion, may include in such monthly estimates payments for materials that will eventually be incorporated in the project, provided that such materials are suitably stored on the site of the project at the time of preparing estimates for payment. Such payment is to be based upon the estimated value thereof as ascertained by the Engineer. Such material when so paid for by the City shall not be removed from the project without consent of the

City and, in case of default on the part of the Contractor, the City may use or cause to be used by others these materials in construction of the project.

The City will retain five percent (5%) of the total contract amount for all work completed including change orders.

Payment of the retainage will be made within forty-five (45) days after project is substantially complete, provided the Contractor submits a Letter of Credit for 125% of the uncompleted work.

The bid proposal price sheets include any and all work for each project. Any requirement shown in the drawings, but not listed separately in the proposal price sheets, are considered subsidiary to the work. This includes but is not limited to abandonments of existing utilities and any potholing required for utility locates prior to boring.

GC.35 Hazardous Materials

As required under Federal Hazardous Communications Standards and certain state and local laws, the Contractor shall provide Material Safety Data Sheets covering all hazardous materials furnished under or otherwise associated with the work under this Contract. The Contractor shall provide the Purchaser with either copies of the applicable Material Safety Data Sheets or copies of a document certifying that no Material Safety Data Sheets are required under any federal, state, or local law, regulation, statute, or ordinance in effect at the jobsite.

Hazardous materials are defined in the applicable statue which may use the terminology "toxic substances" instead of "hazardous materials." The Contractor is responsible for determining if any substance or material furnished, used, applied, or stored under this Contract is within the provisions of any applicable statute.

If the work under this Contract includes onsite construction or erection, the Contractor shall provide written notice of the presence of hazardous materials to local fire, medical, and law enforcement agencies as required with a copy of such notice to the Purchaser.

The Contractor shall provide labeling of hazardous materials and training of employees in the safe usage of such materials as required under any applicable federal, state, or local law, regulation, statute, or ordinance.

GC.36 Liquidated Damages

Time is a material provision of this Agreement. If the Contractor is unable to meet the agreed upon completion dates, the Contractor shall immediately notify the Purchaser and confirm the notice in writing within ten (10) business days of the delaying event. The notice shall contain detailed information of the delay including Contractor’s estimate of the duration of the delay, Contractor’s estimate of the delay’s impact to Contractor’s schedule and Contractor’s plan to mitigate the effects of the delay.

Contractor shall be excused for delays in completion of the work only in accordance with GC.18. In the event of any such delay, Contractor shall only be allowed an extension of the date of completion for a period of time reasonably necessary to overcome the effect of the

delay. Contractor shall not be entitled to any extra compensation for such delay. Contractor shall promptly notify the Purchaser in writing, with confirmation receipt of notification,

The liquidated damages amount per calendar day specified in the proposal form will be assessed, not as a penalty but as predetermined and agreed liquidated damages. The Purchaser and Contractor specifically agree the per calendar day amount to be assessed as liquidated damages is fair and reasonable and not excessive. The parties further agree that said per calendar day amount accurately reflect the anticipated loss and inconvenience to the public and lost revenue to or use by the Purchaser due to the project not being completed by the end of the project period or the end of the contract completion date.

The Purchaser shall have the right to deduct liquidated damages from any money in its hands, otherwise due, or to become due, to the Contractor; to submit invoice for payment; or to sue for and recover compensation for damages for nonperformance of this Contract within the time stipulated.

The Liquidated Damages for this project will be $1,000.00 per calendar day past the project completion date.

GC.37 Consequential Damages
Except for Supplier's third party obligations arising out of or liability for breach of Articles GC.26 and/or GC.30, Purchaser and Supplier will not be liable to each other for loss of profits, loss of use, loss of contracts, or consequential damages arising out of this Contract. This Section will not relieve Supplier of any obligation under GC.36.

GC.38 Limitation of Liability
With the exception of (a) indemnification stated in Article GC.30 and (b) the insurance coverages and limits set forth in Article GC.29, Supplier’s total limit of liability on any claim, whether for breach of Contract, breach of warranty, tort, negligence, strict liability, or any other legal theory, for any loss or damage arising out of or connected to, or resulting from this Contract, shall be limited to the purchase price to be paid by Purchaser.

GC.39 Confidentiality
“Confidential Information” means the confidential or proprietary designs, know-how, processes, trade secrets, and other information owned or controlled by Purchaser, Engineer, or Supplier respectively. Supplier agrees to hold any Confidential Information received in the strictest confidence, shall only use the Confidential Information as necessary to perform the work. Purchaser agrees to hold any Confidential Information received in the strictest confidence and shall only use the confidential information as necessary for engineering, construction, start-up, commissioning, maintenance, or other purposes related to the project. Each party shall use the same degree of care as is used for its own information of similar importance, but no less than reasonable care.

GC.40 Work Eligibility Status
The Contractor is required and hereby agrees to use a federal immigration verification system to determine the work eligibility status of new employees physically performing services within the State of Nebraska. A federal immigration verification system means the electronic

verification of the work authorization program authorized by the Illegal Immigration Reform and Immigrant Responsibility Act of 1996, 8 U.S.C. 1324a, known as the E-Verify Program, or an equivalent federal program designated by the United States Department of Homeland Security or other federal agency authorized to verify the work eligibility status of a newly hired employee.

GC.41 Fair Labor Standards

The Contractor agrees to comply with all current applicable State, Federal, and City fair labor standards in the execution of the contract. Pursuant to the Title VI Non-Discrimination Program of the City of Hastings, Contractor agrees to comply with the provisions set forth by CITY's Title VI Non-discrimination Program, if applicable. A copy of said provisions are as follows:

During the performance of this contract, the contractor, for itself, its assignees and successors in interest (hereinafter referred to as the "contractor") agrees as follows:

(1) Compliance with Regulations: The contractor shall comply with the Regulation relative to nondiscrimination in Federally-assisted programs of the Department of Transportation (hereinafter, "DOT") Title 49, Code of Federal Regulations, Part 21, and the Federal Highway Administration (hereinafter "FHWA") Title 23, Code of Federal Regulations, Part 200 as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

(2) Nondiscrimination: The Contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, or national origin, sex, age, and disability/handicap in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The contractor shall not participate either directly or indirectly in the discrimination prohibited by 49 CFR, section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.

(3) Solicitations for Subcontractors, Including Procurements of Materials and Equipment: In all solicitations either by competitive bidding or negotiation made by the contractor for work to be performed under a subcontract, including procurements of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the contractor of the contractor's obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, or national origin, sex, age, and disability/handicap.

(4) Information and Reports: The contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the (Recipient) or the FHWA to be pertinent to ascertain compliance with such Regulations, orders and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish this information the contractor shall so certify to the (Recipient), or the FHWA as appropriate, and shall set forth what efforts it has made to obtain the information.

(5) Sanctions for Noncompliance: In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, the (Recipient) shall impose such contract sanctions as it or the FHWA may determine to be appropriate, including, but not limited to:

(a.) Withholding of payments to the contractor under the contract until the contractor complies, and/or

(b.) Cancellation, termination or suspension of the contract, in whole or in part.

(6) Incorporation of Provisions: The contractor shall include the provisions of paragraphs (1) through (6) in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto.

The contractor shall take such action with respect to any subcontract or procurement as the (Recipient) or the FHWA may direct as a means of enforcing such provisions including sanctions for non-compliance: Provided, however, that, in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the contractor may request the (Recipient) to enter into such litigation to protect the interests of the (Recipient), and, in addition, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

SECTION 2 - SPECIAL CONDITIONS

SPECIAL CONDITIONS

SC.1 GENERAL. These Special Conditions are nontechnical in nature and shall supplement the General Conditions in the administration and regulation of field construction work performed under these specifications.

SC.2 ENGINEER'S DRAWINGS AND SPECIFICATIONS. After contract award, the Contractor will be furnished two sets of all drawings including revisions thereto and two working copies of the specifications without charge. Additional sets of drawings and revisions thereto and additional copies of specifications may be obtained by payment of printing, handling, and mailing costs. All drawings and specifications shall be returned to the Purchaser upon completion of the work.

SC.3 PROJECT MANAGEMENT. The coordination of all field construction will be under the direction of the Purchaser, who will be responsible for coordinating work between various contractors and for resolving any conflicts between contractors regarding scheduling or coordination.

The time of completion is a basic consideration of this Contract and the Contractor shall be responsible for performing his work in accordance with the specified construction schedule. If at any time the Contractor's work is behind schedule, the Contractor shall increase his forces, work overtime, or otherwise accelerate his operations to comply with the schedule, and shall put into effect definite procedures for getting the work back on schedule. The proposed procedures shall be subject to the Purchaser's acceptance or modification. The procedures adopted shall be put into effect immediately.

The Purchaser will not be responsible for the assignment of personnel, or for obtaining materials or supplies, or for any other services to the Contractor except the coordination of work between contractors and as specifically set forth in the contract documents.

SC.4 CONTRACTOR'S OFFICE AT SITE OF WORK. Not used.

SC.5 FIELD RECORDS. The Contractor shall maintain at the project site an orderly and adequate file of up-to-date copies of all Engineer's drawings and specifications, manufacturer's prints and specifications, and other contract documents and supplementary data.

In addition, the Contractor shall maintain a continuous record of all field changes by means of a set of drawings marked to indicate current "as-built" conditions. This "as-built" set of drawings shall be available for check by the Purchaser in order for him to ascertain that it is being kept current. At the conclusion of the work, the "as-built" drawings and other engineering data, accurately and neatly marked with field changes, shall be submitted to the Purchaser in the required number of copies. The "as-built" drawings and data shall include all revisions to the work made under this Contract, including those made by subcontractors.

SECTION 2 - SPECIAL CONDITIONS

SC.6 CONTRACTOR'S SUPERVISION AT THE SITE. The Contractor shall furnish adequate management, supervisory, and technical personnel on the site to ensure expeditious and competent handling of the work.

A superintendent experienced in construction of the type specified, knowledgeable in the pertinent industry codes and standards, and who is a permanent member of the Contractor's organization, shall be a resident at the project throughout the construction. The superintendent shall be fully authorized to act for the Contractor and to receive whatever orders or notices may be given for the proper prosecution of the work. Contractor shall provide superintendents resume for approval by Owner.

The Contractor's field organization shall include an experienced staff of qualified technical personnel to handle onsite engineering, planning, and direction of all field work.

The Contractor shall be responsible for complete supervision and control of his subcontractors as though they were his own forces. Notice to the Contractor shall be considered notice to any affected subcontractor.

SC.7 SUBCONTRACTS. The Contractor shall perform the majority of the work with his own forces and under the management of his own organization. Specific portions of the work may be subcontracted only by subcontractors who have been listed in the Proposal and who are accepted by the Purchaser as provided in the General Conditions. All subcontractors shall be directly responsible to the Contractor and shall be under his general supervision. All work performed under subcontracts shall be subject to the same contract provisions as the work performed by the Contractor's own forces.

SC.8 RELATIONS WITH OTHER CONTRACTORS. The Contractor shall cooperate with all other contractors who may be performing work in behalf of the Purchaser, and with workmen who may be employed by the Purchaser in the vicinity of the work under this Contract, and he shall conduct his operations to minimize interference with the work of such contractors or workmen. The Contractor shall promptly make good, at his own expense, any injury or damage that may be sustained by other contractors or employees of the Purchaser due to activities associated with this Contract. Any difference or conflict which may arise between the Contractor and other contractor's, or between the Contractor and workmen of the Purchaser, in regard to their work shall be resolved as determined by the Purchaser.

SC.9 ACCEPTANCE OF WORK BY OTHERS. If any part of the Contractor's work is dependent upon the quality and completeness of work performed under another contract, the Contractor shall inspect the other contractor's work and promptly report defects therein which render such work unsuitable for the proper execution of the work under this Contract. Failure to report such defects to the Purchaser shall constitute the Contractor's acceptance of such work as suitable to receive the Contractor's work; provided, however, that the Contractor shall not be responsible for defects which develop after his inspection and which could not have been reasonably detected or foreseen.

SECTION 2 - SPECIAL CONDITIONS

SC.10 METHODS OF FIELD OPERATION. The Contractor shall inform the Purchaser in advance concerning his plans for carrying out each part of the field work. Review by the Purchaser of any plan or method of work proposed by the Contractor shall not relieve the Contractor of any responsibility therefor, and such review shall not be considered as an assumption of any risk or liability by the Purchaser or any officer, agent, or employee thereof. The Contractor shall have no claim because of the failure or inefficiency of any plan or method so reviewed.

Any method of work suggested by the Purchaser, but not specified, shall be used at the risk and responsibility of the Contractor, and the Purchaser will assume no responsibility therefor. The Contractor alone shall be responsible for the safety, adequacy, and efficiency of his construction plant, equipment, and methods.

The Contractor shall be solely and completely responsible for conditions of the jobsite, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The Purchaser's construction review of the Contractor's performance is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

Shutdown of valves or equipment will be made only by Owner's personnel. In the event that an emergency condition warrants, the Contractor shall take direct action to make shutdown, but must notify Owner immediately and remain on worksite to demonstrate what has taken place to Owner's personnel.

SC.11 SAFETY, HEALTH, AND ACCIDENT PREVENTION. The Contractor shall conduct all operations under this Contract in a manner to prevent bodily harm and damage to property. The Contractor shall continuously inspect all operations, work, materials, and equipment; shall conduct health surveys of all work areas; and shall be solely responsible for the discovery, determination, and correction of conditions which constitute a risk of bodily harm or property damage.

The Purchaser will resolve conflicts regarding safety and health measures and practices. The Purchaser will monitor the Contractor's safety and health measures, and may require changes in the Contractor's Safety, Health, and Accident Prevention Program during the performance of the work.

The Contractor shall implement and maintain a written Safety, Health, and Accident Prevention Program specifically applicable to the work. The Contractor's program shall meet the requirements of the codes and regulations of federal, state, local, and other authorities having jurisdiction over this work. The Contractor's Safety, Health, and Accident Prevention Program shall include disciplinary procedures and safety orientation training procedures applicable to Contractor and subcontractor personnel.

The Contractor's Safety, Health, and Accident Prevention Program shall include equipment to be used, sampling strategy and calculations, methods of compliance, and personnel protective equipment. The calibration, sampling, and analytical laboratory procedures used shall be in conformance with OSHA's Industrial Hygiene Field Operations Manual.

SECTION 2 - SPECIAL CONDITIONS

The Contractor's Safety, Health, and Accident Prevention Program shall be submitted for review by the Purchaser 30 days prior to the start of the work at the project site. This review will not relieve the Contractor of his responsibility for safety and health, nor shall such review be construed as limiting in any manner the Contractor's obligation to undertake any action which may be necessary or required to establish and maintain safe working conditions respecting his work at the project site. The Purchaser reserves the right to require the Contractor to modify any portion of his Safety, Health, and Accident Prevention Program.

The Contractor shall immediately correct any unsafe conditions identified by the Purchaser. In the event the Contractor fails to immediately correct such unsafe conditions, the Purchaser may either have the unsafe conditions corrected by others at the Contractor's expense, or direct that the work be stopped in the area of the unsafe condition; however, this right to stop the work shall not give rise to any duty on the part of the Purchaser to exercise this right.

The Contractor shall appoint a qualified Safety and Health Representative. The Safety and Health Representative shall attend all project safety and health meetings. The Contractor's Safety and Health Representative shall have the authority to have unsafe conditions corrected and direct that the work be stopped in the area of the unsafe condition, if deemed necessary.

The Contractor shall maintain accurate accident and injury reports.

The Contractor shall hold regular scheduled meetings to instruct his personnel and his subcontractors' personnel in safety and health practices. The Contractor shall furnish safety and health equipment and enforce the use of such equipment by his employees and the employees of his subcontractors.

The Contractor waives the right to bring claim for damages against the Purchaser or Engineer for any cause whatsoever because of any action taken or not taken including but not limited to the correction of unsafe conditions or work stoppages in connection with the Contractor's Safety, Health, and Accident Prevention Program or such program of another contractor. If such a claim against the Purchaser or Engineer is brought by a third party, the Contractor shall indemnify and defend the Purchaser or Engineer against such claim in accordance with the General Conditions article entitled INDEMNIFICATION.

SC.12 FALL PROTECTION. The OSHA Fall Protection Standard 29 CFR 1926 Subpart M shall be strictly adhered to by the Contractor. Fall protection is required for all of Contractor's Work operations one hundred percent of the time, whether climbing, traveling, or working. **No Work operation is exempt from the six (6) foot fall protection requirement.**

Fall protection body harnesses, lanyards, and lifelines shall be used in accordance with OSHA Standard 1926 Subpart 502D, with the following exceptions:

Full body harnesses shall be used in lieu of safety belts.

Only lanyards with shock absorbers and locking type snap hooks shall be used.

At least two lanyards shall be used to provide one hundred percent fall protection when moving around obstructions, connection points, or other similar items.

Fall protection guardrail systems shall comply with OSHA Standard 1926 Subpart 502(b) except manila, plastic, or synthetic rope shall not be used as guardrails.

Contractor shall provide his own confined space equipment, monitors, and personnel for hole watches.

SC.13 LINES AND GRADES.

Not used

SC.14 PRESERVATION OF MONUMENTS AND STAKES.

Not used

SC.15 PROTECTION OF PROPERTY AND PUBLIC LIABILITY. The Contractor shall be accountable for any damages resulting from his operations. He shall be fully responsible for the protection of all persons including members of the public, employees of the Purchaser, employees of the Engineer, and employees of other contractors or subcontractors, and all public and private property including structures, sewers, and utilities above and below ground.

The Contractor shall furnish and maintain all necessary safety equipment, such as barriers, signs, warning lights, and guards, to provide adequate protection of persons and property.

The Contractor shall give reasonable notice to the owners of public or private property and utilities when such property and utilities are liable to injury or damage through the performance of the work and shall make all necessary arrangements with such owners relative to the removal and replacement or protection of such property or utilities.

SC.16 EMERGENCY PROTECTION. Whenever, in the opinion of the Purchaser, the Contractor has not taken sufficient precaution for the safety of the public or the protection of the work to be constructed under this Contract or of adjacent structures or property, and whenever, in the opinion of the Purchaser, an emergency has arisen and immediate action is considered necessary, then the Purchaser, with or without notice to the Contractor, may provide suitable protection by causing work to be done and material to be furnished and placed. The cost of such work and material shall be borne by the Contractor, and if the same is not paid on presentation of the bills therefor, such costs may be deducted from any amounts due or to become due the Contractor. The performance of such emergency work shall not relieve the Contractor of responsibility for any damage which may occur.

SECTION 2 - SPECIAL CONDITIONS

SC.17 LOSSES FROM NATURAL CAUSES. All loss or damage arising out of the nature of the work, or from the action of the elements, or from floods or overflows, or from ground water, or from any unusual obstruction or difficulty, or any other natural or existing circumstance either known or unforeseen which may be encountered in the prosecution of the work, shall be sustained and borne by the Contractor at his own cost and expense.

SC.18 QUALIFICATIONS OF WORKMEN. The Contractor shall employ only workmen who are competent to perform the work assigned to them and, in the case of skilled labor, who are adequately trained and experienced in their respective trades and who do satisfactory work.

SC.19 SUNDAY, HOLIDAY, AND NIGHT WORK.

Not used.

SC.20 UNFAVORABLE CONSTRUCTION CONDITIONS.

Not used.

SC.21 REJECTED WORK AND MATERIALS. The Contractor, upon written notice from the Purchaser, shall remove from the premises all work and materials rejected as defective, unsound, improper, or in any way failing to conform to the requirements of the contract documents. The Contractor shall at his sole expense make good all work damaged by such removal and shall promptly replace materials damaged or improperly worked by him and re-execute his own work in accordance with the contract. This includes re-executing or replacing the work of any other contractor that is in any way affected by the removal of the defective work. The obligations of the Contractor under this article shall not extend to defective materials or equipment supplied by the Purchaser, if any.

If the Contractor does not remove his rejected work and materials within 10 days after written notice, the Purchaser may remove and replace such work and materials at the expense of the Contractor.

SC.22 PLACING WORK IN SERVICE. If desired by the Purchaser, portions of the work may be placed in service when completed and the Contractor shall provide proper access for this purpose. Such use and operation shall not constitute an acceptance of the work, and the Contractor shall be liable for defects due to faulty construction throughout the duration of this Contract and thereafter as provided under the "Guarantee" provisions of the General Conditions.

SC.23 CLEANLINESS. The Contractor shall give special attention to keeping the worksite clean and free from trash and debris.

Trash, debris, and waste materials shall not be allowed to accumulate, but shall be removed from the site and disposed of by and at the Contractor's expense. No on site burning shall be allowed.

Promptly upon completion of the construction work, all Contractor-owned facilities, materials, and construction plant shall be removed from the site. All surfaces damaged by deposits of foreign materials such as oil, grease, weld spatter, and paint shall be restored to their original conditions.

SC.24 PURCHASE ORDERS. Submittal of purchase orders shall not be required.

SC.25 FIRE PROTECTION. Only work procedures which minimize fire hazards to the extent practicable shall be used. Combustible debris and waste materials shall be collected and removed from the site each day, as provided under CLEANLINESS. Fuels, solvents, and other volatile or flammable materials shall be stored away from the construction and storage areas in well marked, safe containers. Good housekeeping is essential to fire prevention and shall be practiced by the Contractor throughout the construction period. The Contractor shall follow the recommendations of the AGC "Manual of Accident Prevention in Construction" regarding fire hazards and prevention.

The Contractor alone shall be responsible for providing adequate fire protection. Failure of the Contractor to comply with or the Purchaser to enforce, the above requirements shall not relieve the Contractor from any responsibility or obligation under this Contract.

The Contractor shall use and abide by Purchaser’s hot work permit procedures.

SC.26 SECURITY. The Contractor shall be responsible for all materials and equipment in his custody or placed in construction by him. Security methods shall be employed as required to ensure the protection of all materials, equipment, and construction work from theft, vandalism, fire, and all other damage and loss.

The Contractor shall cooperate with the Purchaser regarding all security measures instituted at the jobsite.

SC.27 PROTECTION OF WORK. The Contractor shall be solely responsible for the protection of his work until its final acceptance by the Purchaser.

The Contractor shall have no claim against the Purchaser or the Engineer because of any damage or loss to the Contractor's work and shall be responsible for the complete restoration of damaged work to its original condition complying with the contract documents.

In the event the Contractor's work is damaged by another party not under his supervision or control, the Contractor shall make his claim directly with the party involved. If a conflict or disagreement develops between the Contractor and one of the other contractors concerning the responsibility for damage or loss to the Contractor's work, the conflict shall be resolved as provided under RELATIONS WITH OTHER CONTRACTORS. Such conflict shall not be cause for delay in the restoration of the damaged work. The Contractor shall restore the work immediately and the cost thereof will be assigned pending the resolution of the conflict.

SECTION 2 - SPECIAL CONDITIONS

SC.28 PROTECTION OF CONCRETE SURFACES. Concrete floors and other concrete surfaces shall be protected from chipping, gouging, scratching, staining, and other damage. Damaged sections shall be repaired or removed and replaced subject to the Purchaser's discretion and acceptance.

Heavy planks and mats shall be placed under equipment and materials being stored, moved, assembled, or installed on or above concrete floor surfaces. Nonflammable, oil-resistant coverings shall be used to protect concrete surfaces from staining.

SC.29 PROTECTION OF ELECTRICAL RACEWAY, CABLE, AND LIGHTING FIXTURES. The Contractor shall protect electrical raceway, cable, lighting fixtures, and associated support systems against damage from movement of equipment and materials, welding, flame cutting, and other construction damage. Raceway and supporting structures for raceway and lighting fixtures shall not be used as access scaffolding at any time. Whenever welding or flame cutting operations occur above or near raceways, cables, or lighting fixtures not shielded from such operations by protective covers, the Contractor shall protect the raceways, cables, and lighting fixtures from damage by means of fire-resistant boards or blankets. Damaged materials shall be repaired or replaced subject to the Purchaser's discretion and acceptance.

Where concrete is removed, or holes are filled, the surrounding equipment shall be protected from concrete, water and dust. Where concrete is removed, dust shall be collected.

SC.30 REPAIR OF DAMAGES. The Contractor shall immediately repair any damage which results from this construction or abnormal use, including damage done to the existing facilities. All such repair work shall be acceptable to the Purchaser.

SC.31 INDEPENDENT TESTING LABORATORY. Not Used

SC.32 COOPERATION WITH THE PURCHASER. The performance of construction work which affects the operation of the Purchaser's system facilities shall be scheduled to be performed only at times acceptable to the Purchaser.

In the event that it is necessary to interrupt the Purchaser's operations or the power supply or to impose abnormal operating conditions on the Purchaser's utility system, such procedure must be acceptable to the Purchaser and a complete understanding and agreement must be reached by all parties concerned well in advance of the time scheduled for such operation, and such understanding shall be definite as to date, time of day, and length of time required. All work shall be scheduled to suit the Purchaser's convenience, taking into consideration the facilities and requirements at all times during construction. The Contractor shall perform work which affects the Purchaser's system facilities at times other than regular working hours if required.

SC.33 MINOR DEFECTS. The Contractor shall readjust, straighten, and repair minor defects and fabrication errors which are normally encountered in the Purchaser-furnished equipment and materials. No claims for extra compensation in connection with such work will

be considered unless the claim is made in accordance with the applicable provisions in the General Conditions.

When field labor is needed to correct significant errors in the Purchaser-furnished equipment and materials, the Contractor shall furnish such labor when so requested by the manufacturer or by the Purchaser with the consent of the manufacturer. Such labor shall not be included in this Contract, and the Contractor shall obtain payment for the labor from the manufacturer.

SC.34 CHECKOUT AND INITIAL OPERATION. The Contractor shall render all services and do all work required to place each item of equipment installed by him, including all auxiliaries, piping, and wiring, in operating condition to the satisfaction of the Purchaser. Individual systems and items of equipment shall be completed in a sequence that will permit systematic checkout and trial operation of each such component before it is incorporated in the initial operation.

The Purchaser will furnish operating personnel during checkout and initial operation.

It is anticipated that the startup testing and initial operation will be in progress over extended periods of time.

All regular and overtime payrolls and all other contingencies in connection with the checkout and initial operation of equipment shall be included as a part of the lump sum contract price.

SC.35 CONSTRUCTION PLANT AND TEMPORARY FACILITIES. Temporary facilities are defined in Section 3 General Description and Scope of Work

SC.36 RECEIVING, HANDLING, AND STORAGE. Responsibilities for receiving, handling, and storage are defined in Section 3 General Description and Scope of Work.

SC.37 EQUIVALENT MATERIALS AND EQUIPMENT. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function, and quality desired. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer to determine that the products proposed are equivalent to those named.

Requests for review of equivalency will not be accepted from anyone except the Contractor and such requests will not be considered until after the contract has been awarded.

SC.38 RIGHTS-OF-WAY.

Not used.

SC.38.1 ON PRIVATE PROPERY.

Not used.

SC.39 FENCES.

Not used.

SC.40 PROTECTION OF PUBLIC AND PRIVATE PROPERTY.

Not used.

SC.41 MAINTENANCE OF TRAFFIC.

Not used.

SC.42 BARRICADES AND LIGHTS.

Not used.

SC.43 UNDERGROUND INSTALLATIONS

Not used.

SC.44 LAND FOR CONSTRUCTION PURPOSES.

Not used.

SC.45 ENERGIZED FACILITIES. Existing transmission lines, substations, distribution lines, utility lines, telephone lines and other power and signal service lines will be encountered on the site of the work. These service systems will remain energized and functional during construction.

Temporary outages required by the Contactor to perform certain construction activities will be provided by the Purchaser. The Contractor shall give written notice to the Purchaser a minimum of seven days in advance of any requested outages. The Contractor shall recognize that certain outage restrictions may apply that will not allow for an outage, as requested. The Contractor's proposed schedule shall account for these outage restrictions. No extension of time or any additional compensation will be given for these outage restrictions.

The Contractor shall be completely responsible for the safety and protection of his personnel and the public on the site of the work and shall employ all methods necessary to achieve such safety and also assure continuity of all service systems encountered. These methods shall include, but not be limited to, providing barriers, guard structures, insulating guards and sleeves, warning signs, and prevention of unauthorized access to substations.

SC.46 ARTIFACTS.

Not used.

SC.47 FINAL CLEANUP AND GRADING.

Not used.

SC.48 DUST CONTROL.

Not used.

CITY OF HASTINGS

ENVIRONMENTAL OFFICE
RTU REPLACEMENT

1228 NORTH DENVER AVENUE
HASTINGS, NEBRASKA 68901

INDEX OF DRAWINGS

MECHANICAL

ELECTRICAL

09/30/2024
20240619

PROJECT DRAWINGS

CA-2169 09/30/2024

I, CRAIG JOHNSON, AM THE COORDINATING PROFESSIONAL FOR THE ENVIRONMENTAL OFFICE RTU REPLACEMENT PROJECT.

ALVINE Engineering

Omaha:
1201 Cass Street
Omaha, NE 68102
Phone: (402) 346-7007

Lincoln:
1220 Lincoln Mall, Suite 200
Lincoln, NE 68508
Phone: (402) 477-6161

Oklahoma City:
1001 W. Wilshire Blvd., Suite 102
Oklahoma City, OK 73116
Phone: (405) 936-3480

Des Moines:
400 East Court Avenue, Suite 130
Des Moines, IA 50309
Phone: (515) 243-0569

MECHANICAL SYMBOLS

PLUMBING

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
AV	ACID VENT	140°	HOT WATER 140°	GCO	GRADE CLEAN OUT
AW	ACID WASTE (ABOVE FLOOR)	140°	HOT WATER CIRCULATING 140°		DOUBLE GRADE CLEAN-OUT
AW	ACID WASTE (BELOW FLOOR)	G	NATURAL GAS	HB	HOSE BIBB
	COLD WATER (CW)	OF	OVERFLOW STORM DRAIN (ABOVE FLOOR)	WH	WALL HYDRANT (NON-FREEZE TYPE)
S	COLD SOFT WATER	OF	OVERFLOW STORM DRAIN (BELOW FLOOR)	Y.H.	YARD HYDRANT
A	COMPRESSED AIR		SANITARY DRAIN (ABOVE FLOOR)	BFP	BACK FLOW PREVENTER
	EXISTING SANITARY DRAIN (ABOVE FLOOR)		SANITARY SEWER (BELOW FLOOR)	FD-X	FLOOR DRAIN SIZE-TYPE
	EXISTING SANITARY SEWER (BELOW FLOOR)	SS	SITE STORM SEWER	FS-X	FLOOR SINK SIZE-TYPE
S	EXISTING STORM DRAIN (ABOVE FLOOR)	S	STORM DRAIN (ABOVE FLOOR)	RD-X	ROOF DRAIN SIZE-TYPE
S	EXISTING STORM DRAIN (BELOW FLOOR)	S	STORM DRAIN (BELOW FLOOR)	DS	DOWN SPOUT
SS	EXISTING SUB SOIL DRAIN	SS	SUB SOIL DRAIN	MH	MANHOLE
AW	EXISTING ACID WASTE (ABOVE FLOOR)	V	VENT	VTR	VENT THROUGH ROOF ON RISER
AW	EXISTING ACID WASTE (BELOW FLOOR)	W	SITE WATER PIPING		
	HOT WATER (HW)	V	VACUUM BREAKER	1	PLUMBING RISER NUMBER
	HOT WATER CIRCULATING (HWC)		GAS COCK		
S	HOT SOFT WATER		RUNNING TRAP	SH	SHOWER
S	HOT SOFT WATER RECIRCULATING	CO OR CO	CLEAN OUT		

HEATING - VENTILATING - AIR-CONDITIONING

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
CWS	CHILLED WATER SUPPLY		AUTOMATIC CONTROL VALVE, 2-WAY		TURNING VANES
CWR	CHILLED WATER RETURN		AUTOMATIC CONTROL VALVE, 3-WAY		SUPPLY, OUTDOOR, OR MIXED AIR DUCT END OR RISER (SA) (OA) (MA)
PC	CONDENSATE OR BOILER FEED PUMP DISCHARGE		PRESSURE REGULATING VALVE (PRV)		RETURN EXHAUST OR RELIEF AIR DUCT END OR RISER (RA) (EA) (RLFA)
CS	CONDENSER WATER SUPPLY FROM TOWER		PIPE IN SLEEVE	X/X	RECTANGULAR DUCTWORK (FIRST NUMBER IS SIDE SHOWN)
CR	CONDENSER WATER RETURN TO TOWER		VALVE IN VERTICAL PIPE	XØ	ROUND DUCT
CD	COIL OR EQUIPMENT DRAIN		F AND T TRAP CAP LBS/HR	X/X	FLAT OVAL (FIRST NUMBER IS THE SIDE SHOWN)
GS	GLYCOL SUPPLY		BUCKET TRAP CAP LBS/HR		VOLUME DAMPER
GR	GLYCOL RETURN	AQ	AIR QUALITY SENSOR		
FOS	FUEL OIL SUPPLY	A	AQUASTAT	M	MOTORIZED DAMPER
FOR	FUEL OIL RETURN	CO2	C02 SENSOR		
FOV	FUEL OIL VENT	H	HUMIDISTAT	FRD	FIRE DAMPER WITH ACCESS DOOR
G	NATURAL GAS	S	REMOTE SENSOR		
HPWS	HEAT PUMP WATER SUPPLY	T	THERMOSTAT	FSD M	COMBINATION FIRE AND SMOKE DAMPER WITH ACCESS DOOR
HPWR	HEAT PUMP WATER RETURN	T RS	THERMOSTAT WITH REMOTE SENSOR		
HPR	HIGH PRESSURE CONDENSATE RETURN		SOLENOID VALVE (REFRIGERANT)	SD M	SMOKE DAMPER WITH ACCESS DOOR
HPS	HIGH PRESSURE STEAM		THERMOSTATIC EXPANSION VALVE (REFRIGERANT)		
HWS	HOT WATER SUPPLY		SIGHT GLASS	SA	SOUND ATTENUATOR
HWR	HOT WATER RETURN		MANUAL AIR VENT		FLEX CONNECTION
LPR	LOW PRESSURE CONDENSATE RETURN	P T	PRESSURE OR TEMPERATURE MEASURING POINTS	SIZE TYPE CFM	SUPPLY REGISTER OR GRILLE
LPS	LOW PRESSURE STEAM	FS	FLOW SWITCH		
MPR	MEDIUM PRESSURE CONDENSATE RETURN	1	HEATING RISER	SIZE TYPE CFM	RETURN REGISTER OR GRILLE
MPS	MEDIUM PRESSURE STEAM	AD	ACCESS DOOR - SIZE AS SHOWN OR PER SPEC.		
RL	REFRIGERANT LIQUID		EXPANSION LOOP, LENGTH AND DEPTH	X X / X	TYP DIFFUSER — NECK SIZE, MARK / CFM
RS	REFRIGERANT SUCTION	FT-1 MBH	FINTUBE-TYPE CAPACITY MBH (SHADED AREA INDICATES ELEMENT LOCATION)	X X / X	TYP EXHAUST/RETURN GRILLE — NECK SIZE, MARK / CFM
RD	REFRIGERANT HOT GAS DISCHARGE				
B.D.D.	BACK-DRAFT DAMPER (COUNTER BALANCED)		NEW TO EXISTING CONNECTION	X / X	MECHANICAL EQUIPMENT WITH ELEC CONNECTION SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE
			POINT OF DISCONNECT	OR	BREAK / CONTINUATION

ABBREVIATIONS

AFF	ABOVE FINISHED FLOOR
AHJ	AUTHORITY HAVING JURISDICTION
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	STANDARD SPECIFICATIONS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS
AUX	AUXILIARY
AV	ACID VENT
AVG	AVERAGE
AW	ACID WASTE
AWG	AMERICAN WIRE GAUGE
BMCS	BUILDING MANAGEMENT CONTROL SYSTEM
BFP	DOUBLE CHECK BACKFLOW PREVENTER
BLDG	BUILDING
BTU	BRITISH THERMAL UNIT
BTUH	BRITISH THERMAL UNIT PER HOUR
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CL	CENTER LINE
CLG	CEILING
CLR	CLEAR
CPVC	CHLORINATED POLYVINYL CHLORIDE
CRAC	COMPUTER ROOM AIR CONDITIONER
CV	CONSTANT VOLUME
DDCV	DOUBLE DETECTOR CHECK VALVE ASSEMBLY BACKFLOW PREVENTER
DIA	DIAMETER
DISC	DISCONNECT
DIST	DISTRIBUTION
DN	DOWN
DPAC	DRY PIPE AIR COMPRESSOR
DPV	DRY PIPE VALVE
DWG	DRAWING
DX	DIRECT EXPANSION
EA	EXHAUST AIR
EHC	ELECTRIC HEATING COIL
EL	ELEVATION
ELEC	ELECTRICAL
EMS	ENERGY MANAGEMENT SYSTEM
EOA	ECONOMIZER OUTDOOR AIR
EPO	EMERGENCY POWER OFF
EQUIP	EQUIPMENT
EXH	EXHAUST
EXIST	EXISTING
F	FIRE WATER
FA	FIRE ALARM
FCO	FLOOR CLEAN OUT
FDC	FIRE DEPARTMENT CONNECTION
FHC	FIRE HOSE CABINET
FHV	FIRE HOSE VALVE
FL	FLOOR
FT	FEET
FW	FILTERED WATER
GA	GAUGE
GALV	GALVANIZED
GC	GENERAL CONTRACTOR
GEN	GENERATOR
GPM	GALLONS PER MINUTE
GW	GARAGE WASTE
HGT	HEIGHT
HP	HORSEPOWER
HTG	HEATING
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HZ	HERTZ, HIGH ZONE WET STANDPIPE
IE	INVERT ELEVATION
IP	INTERNET PROTOCOL
KW	KILOWATT
LBS	POUNDS
LZ	LOW ZONE WET STANDPIPE
MA	MIXED AIR
MAX	MAXIMUM
MBH	1000 BTU/HOUR
MECH	MECHANICAL
MERV	MINIMUM EFFICIENCY REPORTING VALUE
MIN	MINIMUM
MISC	MISCELLANEOUS
MOA	MINIMUM OUTDOOR AIR
MTD	MOUNTED
NC	NORMALLY CLOSED
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NOM	NOMINAL
NPW	NON-POTABLE WATER
NTS	NOT TO SCALE
OA	OUTDOOR AIR
OC	ON CENTER
OFCI	OWNER FURNISHED CONTRACTOR INSTALLED
PERP	PERPENDICULAR
PIV	POST INDICATOR VALVE
PLBG	PLUMBING
PNL	PANEL
PS	PLASTER SINK
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
PWR	POWER
RA	RETURN AIR
REQD	REQUIRED
RGS	RIGID GALVANIZED STEEL
RH	RELATIVE HUMIDITY
RLFA	RELIEF AIR
RM	ROOM
RO	REVERSE OSMOSIS WATER
RPZ	REDUCED PRESSURE ZONE BACKFLOW PREVENTER
SA	SUPPLY AIR
SAN	SANITARY
SCHD	SCHEDULE
SCW	SOFT COLD WATER
SHW	SOFT HOT WATER
SIM	SIMILAR
SM	SPRINKLER MAIN
SMACNA	SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
SPECS	SPECIFICATIONS
SS	STAINLESS STEEL
STD	STANDARD
TEMP	TEMPERATURE
TYP	TYPICAL
UG	UNDERGROUND
UL	UNDERWRITERS LABORATORY
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SUPPLY
VA	VOLT-AMPS
VERT	VERTICAL
VFC	VARIABLE FREQUENCY CONTROL
VTR	VENT THROUGH ROOF
W	WATT
WG	WATER GAUGE
WP	WEATHERPROOF
XFMR	TRANSFORMER

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:

1. 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.
2. 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.
3. COORDINATE SHUT DOWN OF ALL UTILITIES FOR DEMOLITION WORK WITH THE OWNER.
4. DISCONNECT AND REMOVE MECHANICAL SYSTEMS, EQUIPMENT, AND COMPONENTS AS 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.
   DUCTS TO BE REMOVED: REMOVE PORTIONS OF DUCT AND CAP REMAINING DUCTS WITH THE SAME OR COMPATIBLE DUCTWORK MATERIAL.
   EQUIPMENT TO BE REMOVED: DISCONNECT AND CAP SERVICES AND REMOVE EQUIPMENT.
   EQUIPMENT TO BE REMOVED AND SALVAGED: DISCONNECT AND CAP SERVICES AND REMOVE EQUIPMENT AND DELIVER TO OWNER.
5. 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.
6. CONTRACTOR IS REQUIRED TO VISIT SITE AND FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO BIDDING PROJECT.
7. COORDINATE DEMOLITION WITH THE WORK OF OTHER TRADES. PROVIDE TEMPORARY UTILITIES AS REQUIRED TO ALLOW THE WORK OF OTHER TRADES TO PROCEED.
8. DUCTWORK, PIPING, PLUMBING, AND EQUIPMENT SHOWN BOLD AND HATCHED SHALL BE REMOVED TO THE EXTENTS INDICATED.

DETAIL NOTE:

1. PROJECT DETAILS ARE PROVIDED ON DESIGNATED DETAIL SHEETS. DETAILS APPLY TO THE ENTIRE PROJECT IN ALL LOCATIONS WHERE DETAILED CONDITION EXISTS AND ARE ONLY REFERENCED TO PROVIDE CLARITY IF NECESSARY.

GENERAL NOTES:

1. THIN LINE ITEMS INDICATE EXISTING TO REMAIN. BOLD LINE ITEMS INDICATE NEW WORK.
2. CONTRACTOR IS RESPONSIBLE FOR ANY CUTTING AND PATCHING NEEDED FOR MECHANICAL INSTALLATION. PATCHING MUST MATCH EXISTING.

HVAC GENERAL NOTES:

1. DO NOT RUN DUCTWORK ABOVE ELECTRICAL PANELS OR IN CODE REQUIRED CLEARANCE SPACES. COORDINATE ALL ROUTING WORK WITH ALL OTHER TRADES.
2. 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.
3. CONTRACTOR SHALL COORDINATE LOCATION OF DUCTWORK IN CEILING SPACE WITH ALL TRADES PRIOR TO FABRICATION AND INSTALLATION OF DUCTWORK.
4. FOR GENERAL DUCTWORK CONSTRUCTION, SEE DUCT FITTING DETAILS.
5. DUCTWORK AND EQUIPMENT SHOWN WITH THIN LINES INDICATES EXISTING TO REMAIN. DUCTWORK AND EQUIPMENT SHOWN WITH BOLD LINES INDICATES NEW.
6. PROVIDE VOLUME DAMPER IN ALL BRANCH TAKEOFFS CONNECTING TO DIFFUSERS, REGISTERS, OR GRILLES AND IN LOCATIONS INDICATED.
7. PROVIDE REMOTE VOLUME DAMPER BALANCING POSITION CONTROL FOR ALL VOLUME DAMPERS MOUNTED ABOVE NON-ACCESSIBLE CEILINGS.
8. PROVIDE CLEARANCES TO ALL EQUIPMENT AS REQUIRED BY MANUFACTURERS' INSTALLATION AND OPERATION REQUIREMENTS AND/OR BY CODE.
9. CAP ENDS OF ALL INSTALLED DUCTWORK DURING CONSTRUCTION TO MINIMIZE DIRT, DEBRIS, AND FOREIGN OBJECTS FROM ENTERING THE DUCT SYSTEM.
10. COORDINATE SCHEDULE OF SHUTDOWN FOR EXISTING HVAC SYSTEMS, FOR INSTALLATION OF NEW HVAC SYSTEMS, WITH THE OWNER'S REPRESENTATIVE PRIOR TO SHUTDOWN.
11. ALL INSULATION SHALL MEET THE ENERGY CODE'S INSTALLED R VALUE REQUIREMENTS.

No	Revisions	Date

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MECHANICAL SYMBOLS, NOTES, AND ABBREVIATIONS

CITY OF HASTINGS ENVIRONMENTAL OFFICE RTU REPLACEMENT

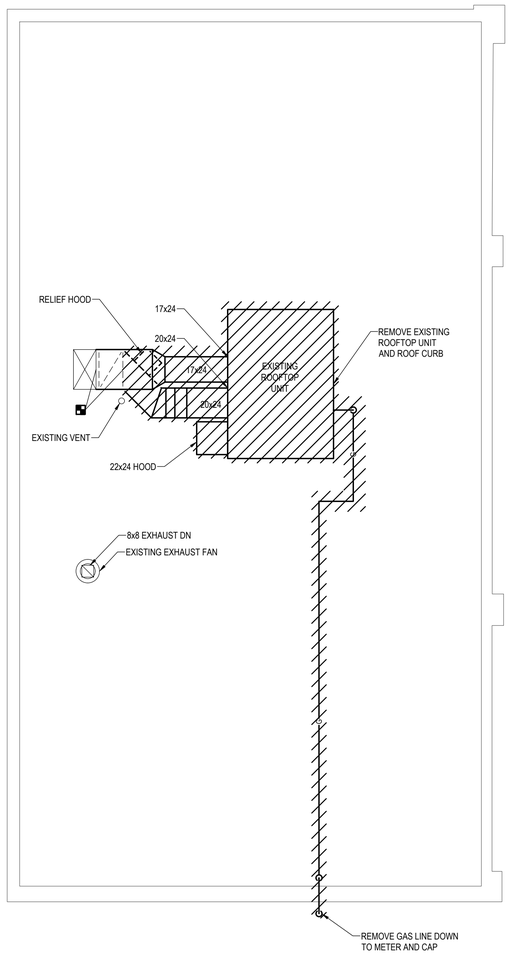
HASTINGS NEBRASKA

ALVINE Engineering

Omaha: 1201 Cass Street, Omaha, NE 68102, Phone: (402) 346-7007
Lincoln: 1220 Lincoln Mall, Suite 200, Lincoln, NE 68508, Phone: (402) 477-6161
Oklahoma City: 1001 W, Wilshire Blvd., Suite 102, Oklahoma City, OK 73116, Phone: (405) 936-3480
Des Moines: 400 East Court Avenue, Suite 130, Des Moines, IA 50309, Phone: (515) 243-0569

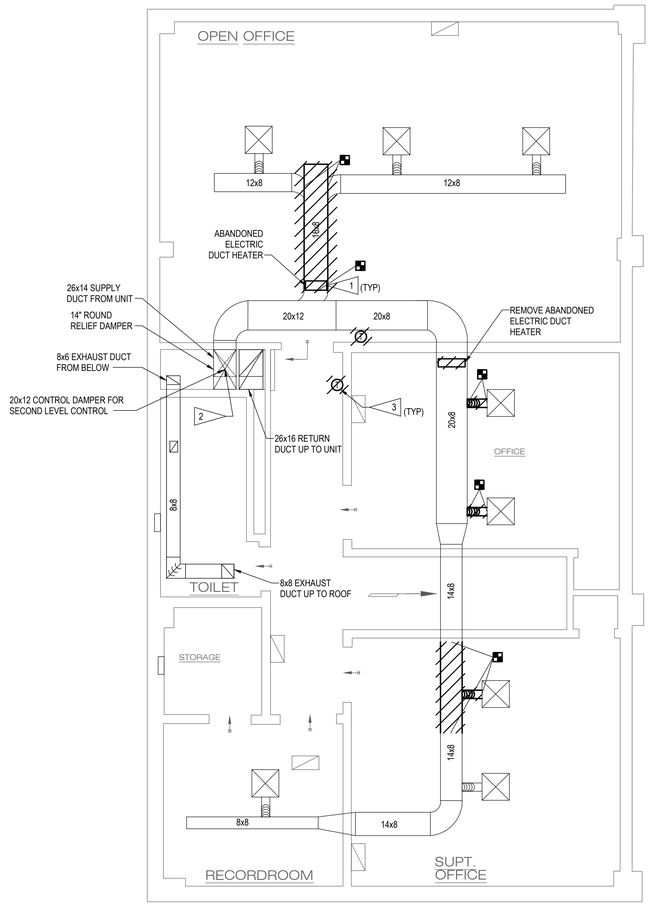
PROFESSIONAL MECHANICAL ENGINEER — CRAIG P. JOHNSON E-15444 — STATE OF NEBRASKA
CA-2169 09/30/2024

Designed	File Name
CPJ	20240619M0-0
Drawn	Project No.
JCS	20240619
Checked	Drawing No.
BAH	M0-0
Date	
09/20/2024	



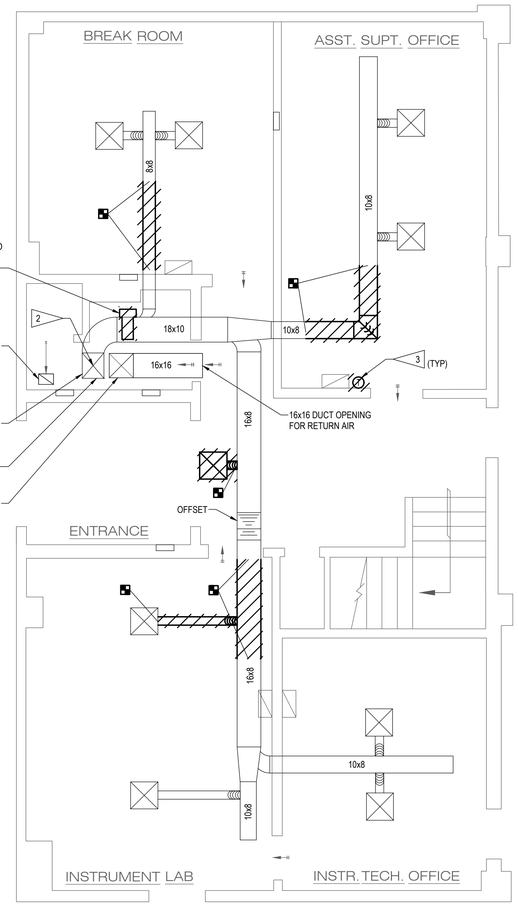
ROOF PLAN - DEMOLITION

SCALE: 1/4" = 1'-0"



SECOND FLOOR PLAN - DEMOLITION

SCALE: 1/4" = 1'-0"



MAIN FLOOR PLAN - DEMOLITION

SCALE: 1/4" = 1'-0"

FLAG NOTES

1. REMOVE ALL EXISTING ELECTRIC DUCT HEATERS AND ASSOCIATED THERMOSTATS AND CONTROLS. PATCH EXISTING DUCTWORK.
2. REMOVE FIRST AND SECOND LEVEL CONTROL DAMPERS AND ASSOCIATED THERMOSTATS AND CONTROLS. PATCH EXISTING DUCTWORK.
3. REMOVE EXISTING THERMOSTAT. REPAIR AND PAINT WALL TO MATCH EXISTING CONDITION.

No	Revisions	Date

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MECHANICAL
DEMOLITION

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

HASTINGS NEBRASKA

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Omaha: 1201 Cass Street, Omaha, NE 68102, Phone: (402) 346-2007
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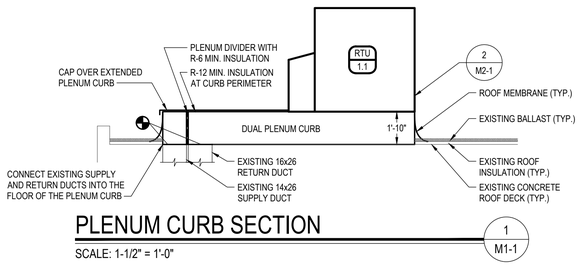
PROFESSIONAL MECHANICAL ENGINEER
CRAIG P. JOHNSON
E-15444
STATE OF NEBRASKA
CA-2169 09/30/2024

Designed: CPJ	File Name: 20240619M0-1
Drawn: NMP	Project No.: 20240619
Checked: BAH	Drawing No.: M0-1
Date: 09/20/2024	

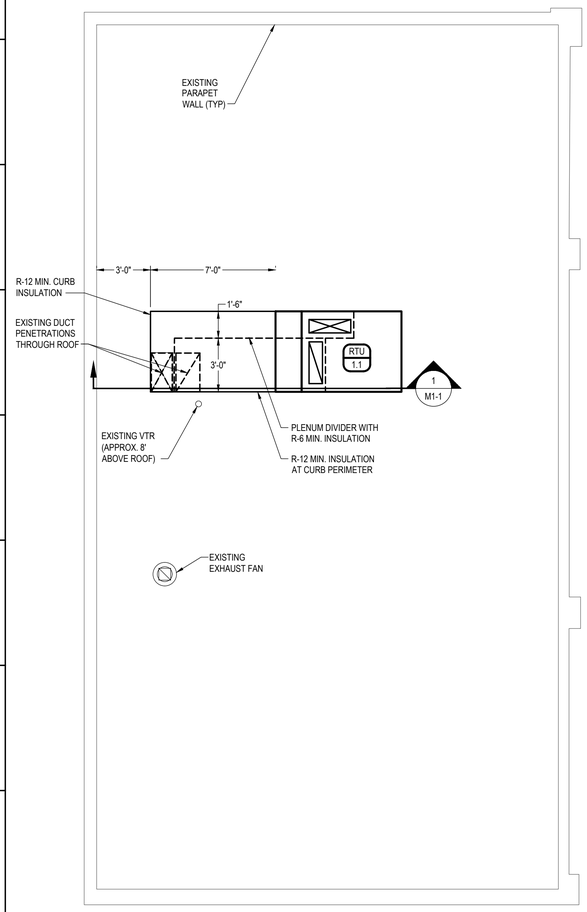
September 30, 2024 3:55 PM Jonathan Storm



PLENUM CURB SECTION

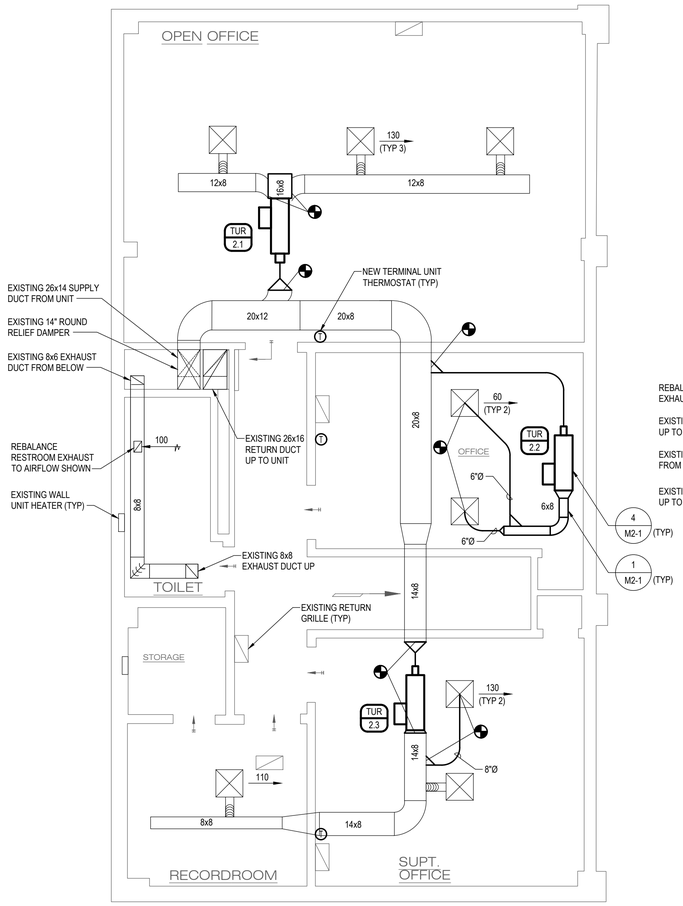
SCALE: 1-1/2" = 1'-0"

1
M1-1



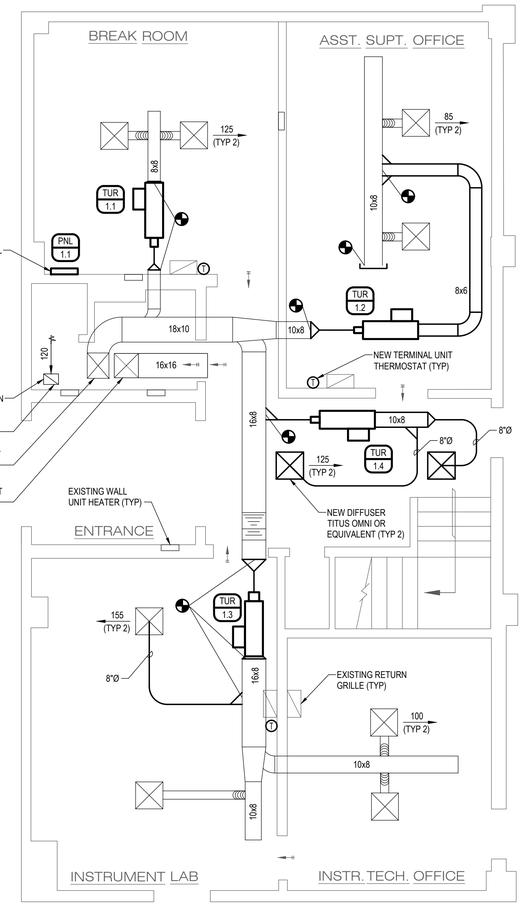
ROOF PLAN - NEW WORK

SCALE: 1/4" = 1'-0"



SECOND FLOOR PLAN - NEW WORK

SCALE: 1/4" = 1'-0"



MAIN FLOOR PLAN - NEW WORK

SCALE: 1/4" = 1'-0"

FLAG NOTES

No	Revisions	Date

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MECHANICAL
NEW WORK

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

HASTINGS NEBRASKA

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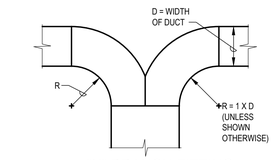
PROFESSIONAL MECHANICAL ENGINEER
CRAIG P. JOHNSON
E-15444
STATE OF NEBRASKA

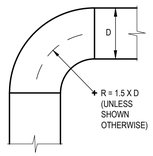
CA-2169 09/30/2024

Designed: CPJ	File Name: 20240619M1-1
Drawn: JCS	Project No.: 20240619
Checked: BAH	Drawing No.: M1-1
Date: 09/20/2024	

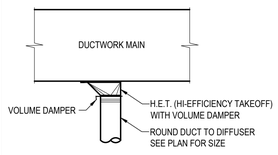
September 30, 2024 3:35 PM Jonathan Storm



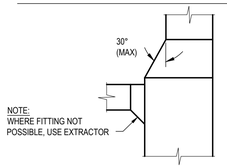
"Y" BRANCH FITTING



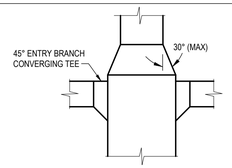
90° ELBOW



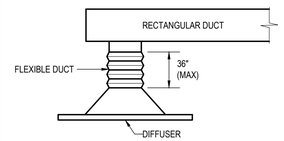
DIFFUSER TAKE-OFF



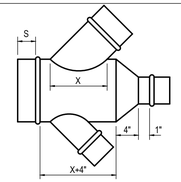
SINGLE BRANCH TAKE-OFF



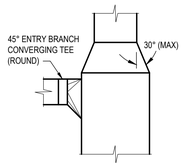
DOUBLE BRANCH TAKE-OFF



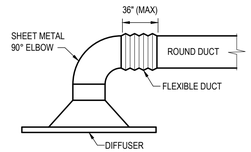
SUPPLY AIR DIFFUSER



45° LATERAL CROSS WITH REDUCER



45° ROUND TAKE-OFF



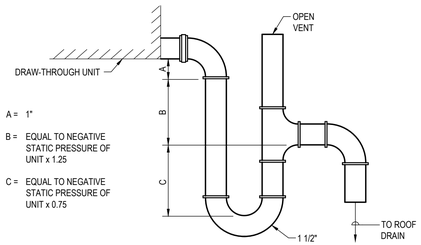
SUPPLY AIR DIFFUSER

DUCT FITTING DETAILS

NO SCALE

M-MD-DuctFittingDetails2020-09-07

1 / M2-1



NOTE:

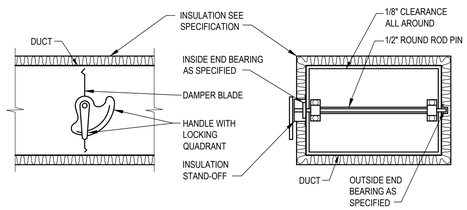
1. TYPICAL AT EACH AIR HANDLING UNIT DRAIN PAN OR SECTION DRAIN.

CONDENSATE DRAIN

NO SCALE

M-MD-CondensateDrain 2017-02-15

2 / M2-1



NOTES:

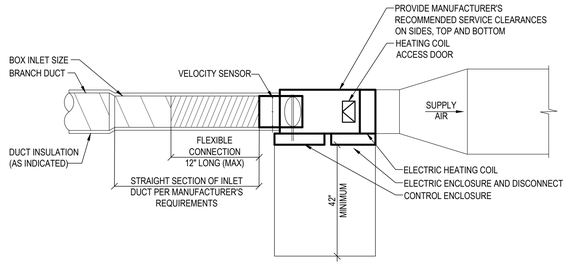
1. DELETE INSULATION STAND-OFF ON DUCTWORK WITHOUT EXTERIOR INSULATION.
2. DETAIL SHOWS SINGLE BLADE DAMPER. DAMPER INSTALLATION SHALL BE SIMILAR FOR MULTI-BLADE DAMPERS AND ROUND DAMPERS.

VOLUME DAMPER

NO SCALE

M-MD-VolumeDamper 2014-06-13

3 / M2-1



SINGLE DUCT AIR TERMINAL UNIT ELECTRIC REHEAT COIL

NO SCALE

M-MD-SingleDuctAirTermUnitElecReheatCoil 2022-04-11

4 / M2-1

No	Revisions	Date

MECHANICAL
DETAILS

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

HASTINGS NEBRASKA

ALVINE Engineering

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PROFESSIONAL MECHANICAL ENGINEER
CRAIG P. JOHNSON
E-15444
STATE OF NEBRASKA
CA-2169 09/30/2024

Designed: CPJ	File Name: 20240619M2-1
Drawn: JCS	Project No.: 20240619
Checked: BAH	Drawing No.: M2-1
Date: 09/20/2024	

September 30, 2024 3:53 PM Jonathan Storm

ROOFTOP UNIT SCHEDULE (ELECTRIC HEAT)

MARK	LOCATION	CONFIGURATION	AIRFLOW DATA				COOLING DATA							HEATING DATA		FAN DATA				DIMENSIONS (LxWxH) (IN)	OPERATING WEIGHT (LBS)	MANUF.	MODEL	REMARKS
			AIRFLOW (CFM)	EXT S.P. (IN. W.C.)	MAX. OUTSIDE AIRFLOW (CFM)	MIN. OUTSIDE AIRFLOW (CFM)	AMBIENT AIR TEMP (°F)	MIN EER (AHRI)	EAT (DB/WB) (°F)	TOTAL COOLING (MBH)	SENSIBLE COOLING (MBH)	NUMBER OF COMPRESSORS	STEPS OF UNLOADING	HEATER CAPACITY (KW)	NO. OF STEPS	SUPPLY FAN		RETURN/RELIEF AIR						
																SIZE (IN)	HP	SIZE (IN)	HP					
RTU-1.1	ROOF	DRAW-THROUGH	2000	1.5	2000	300	105	11.1	81/63	64.5	59.1	1	MODULATING	12	SCR	14	3	12	1.2	84.5x53.5x69.5	1186	DAIKIN	REBEL DPSC06B	1,2,3,4,5

REMARKS:

1. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE ON SHEET E2-1 FOR ELECTRICAL DATA.
2. PROVIDE A DUAL PLENUM CURB SIZED TO FIT THE INSTALLED ROOFTOP UNIT. SEE THE MECHANICAL DRAWINGS AND SPECIFICATIONS FOR MORE INFORMATION.
3. PROVIDE WITH FUSED DISCONNECT, 65KA SCCR RATING, AND SINGLE POINT POWER CONNECTION.
4. PROVIDE WITH A VARIABLE SPEED SUPPLY FAN, A DIGITAL SCROLL COMPRESSOR, AND FACTORY CONTROLS TO ALLOW FOR VARIABLE AIR VOLUME CONTROL THAT MAINTAINS DUCT STATIC PRESSURE AND DISCHARGE AIR TEMPERATURE SETPOINTS.
5. PROVIDE WITH 0 TO 100% ENTHALPY ECONOMIZER AND POWER EXHAUST.

AIR TERMINAL UNIT SCHEDULE

MARK	SERVES	TYPE	CFM				MAX S. P. IN. W.G. [3]	NC @ MIN S.P. [4]	INLET DIAMETER (IN)	INLET BRANCH DUCT (IN)	OUTLET DUCT SIZE (IN)	HEATING COIL				CONTROLLER	OVERALL DIMENSIONS (LxWxH) (IN) [6]	MAX WEIGHT (LBS)	MANUFACTURER	MODEL	REMARKS
			MAX COOLING	MAX HEATING	MIN OCCUPIED [2]	MIN UNOCCUPIED [2]						MBH [5]	KW	EAT (DEG F)	LAT (DEG F)					
TUR-1.1	SEE PLANS	SINGLE DUCT/VARIABLE VOLUME	250	250	95	0	0.15	31	5	6	12 X 8	9.5	3.00	55.00	92.9	DIGITAL	37 X 12 X 8	50	TITUS	DESV	1,2,3,4,5,6,7
TUR-1.2	SEE PLANS	SINGLE DUCT/VARIABLE VOLUME	170	170	60	0	0.08	33	4	5	12 X 8	6.2	2.00	55.00	92.2	DIGITAL	37 X 12 X 8	50	TITUS	DESV	1,2,3,4,5,6,7
TUR-1.3	SEE PLANS	SINGLE DUCT/VARIABLE VOLUME	510	510	190	0	0.34	25	7	8	12 X 10	18.8	6.00	55.00	92.2	DIGITAL	37 X 12 X 10	75	TITUS	DESV	1,2,3,4,5,6,7
TUR-1.4	SEE PLANS	SINGLE DUCT/VARIABLE VOLUME	250	250	138	0	0.15	31	5	6	12 X 8	9.0	3.00	55.00	92.9	DIGITAL	37 X 12 X 10	50	TITUS	DESV	1,2,3,4,5,6,7
TUR-2.1	SEE PLANS	SINGLE DUCT/VARIABLE VOLUME	480	355	145	0	0.36	25	6	7	12 X 8	14.5	5.00	55.00	95.5	DIGITAL	37 X 12 X 8	50	TITUS	DESV	1,2,3,4,5,6,7
TUR-2.2	SEE PLANS	SINGLE DUCT/VARIABLE VOLUME	120	85	45	0	0.08	29	4	5	12 X 8	2.4	1.50	55.00	94.5	DIGITAL	37 X 12 X 8	50	TITUS	DESV	1,2,3,4,5,6,7
TUR-2.3	SEE PLANS	SINGLE DUCT/VARIABLE VOLUME	330	330	95	0	0.15	24	5	6	12 X 8	13.7	4.50	55.00	93.4	DIGITAL	37 X 12 X 8	50	TITUS	DESV	1,2,3,4,5,6,7

REMARKS:

1. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE ON SHEET E2-1 FOR ELECTRICAL DATA.
2. MINIMUM AIR FLOW FOR PRESSURE INDEPENDENT CONTROL.
3. TOTAL AIR PRESSURE DIFFERENCE ACROSS BOX AND COIL AT MAXIMUM CFM.
4. DISCHARGE UNIT NOISE AT 1.5" MAXIMUM PRESSURE DIFFERENCE. BASED ON ROOM ATTN OF 10 DB (LW RE: 10 E-12 WATTS).
5. HEATING CAPACITY BASED ON HEATING CFM, EAT AND LAT IN SCHEDULE. PROVIDE WITH ELECTRIC HEATING COIL WITH THE MANUFACTURER'S SCR CONTROLLER TO PROVIDE MODULATING HEATING CAPACITY.
6. DIMENSIONS INCLUDE CONTROL PANEL, REHEAT COIL, AND ACCESS DOOR.
7. PROVIDE THE MANUFACTURER'S DOOR INTERLOCK DISCONNECT SWITCH AND A FACTORY MOUNTED AND WIRED 24 VOLT TRANSFORMER WHICH POWERS BOTH THE ELECTRIC HEATING COIL SCR CONTROLLER AND THE THIRD-PARTY FIELD INSTALLED TERMINAL UNIT CONTROLS FROM THE SINGLE POINT POWER CONNECTION.

No	Revisions	Date

MECHANICAL
SCHEDULES

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

HASTINGS NEBRASKA

ALVINE Engineering

Omaha: 1201 Cass Street, Omaha, NE 68102, Phone: (402) 346-7007
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Oklahoma City: 1001 W. Wilshire Blvd., Suite 102, Oklahoma City, OK 73116, Phone: (405) 936-3480
Des Moines: 400 East Court Avenue, Suite 130, Des Moines, IA 50309, Phone: (515) 243-0569

PROFESSIONAL MECHANICAL ENGINEER
CRAIG P. JOHNSON
E-15444
STATE OF NEBRASKA
CA-2169 09/30/2024

Designed	CPJ
Drawn	JCS
Checked	BAH
Date	09/20/2024
File Name	20240619M3-1
Project No.	20240619
Drawing No.	M3-1

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ELEGEND 2024-05-06

ELECTRICAL SYMBOLS

LIGHTING AND POWER

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
S	SINGLE POLE SWITCH		SIMPLEX RECEPTACLE		LIGHTING PANEL - FLUSH MOUNTED
$	LOW VOLTAGE SWITCH/CONTROL	G,T,U	DUPLEX RECEPTACLE "G" SUBSCRIPT INDICATES GFCI, "T" SUBSCRIPT INDICATES TAMPER RESISTANT TYPE, "U" SUBSCRIPT INDICATES COMBINATION USB CHARGING STATION		LIGHTING PANEL - SURFACE MOUNTED
S_2	DOUBLE POLE SWITCH				DIMMING/RELAY PANEL
S_3	3-WAY SWITCH		AUTOMATICALLY CONTROLLED DUPLEX RECEPTACLE		DISTRIBUTION PANEL, SWITCHBOARD, OR MOTOR CONTROL CENTER
S_4	4-WAY SWITCH		ISOLATED GROUND DUPLEX RECEPTACLE	T	TRANSFORMER
S_D	DOOR SWITCH		HOSPITAL GRADE DUPLEX RECEPTACLE	ATS	AUTOMATIC TRANSFER SWITCH
S_{MC}	MOMENTARY CONTACT SWITCH		RED DUPLEX RECEPTACLE		ENCLOSED CIRCUIT BREAKER
S_T	TIMER SWITCH		DUPLEX RECEPTACLE - SPLIT WIRED		SINGLE PHASE MAGNETIC MOTOR STARTER
S_{TE}	SINGLE POLE MANUAL MOTOR STARTER WITH THERMAL OVERLOAD AND PILOT LIGHT		AUTOMATICALLY CONTROLLED DUPLEX RECEPTACLE - SPLIT WIRED		THREE PHASE MAGNETIC MOTOR STARTER
S	SWITCH AND FUSE		DRYER RECEPTACLE NEMA 14-30 (125/250V 30A)		COMBINATION MAGNETIC STARTER/DISCONNECT
S	SWITCH AND FUSTAT		SPECIAL PURPOSE RECEPTACLE (NEMA CONFIGURATION AS NOTED)	A/B/C/D	SAFETY SWITCH (FUSED UNLESS OTHERWISE NOTED) "A"=AMP RATING, "B"=POLES, "C"=FUSE SIZE, "D"=NEMA ENCLOSURE; FOR FUSE SIZE, "MR"=MFGR RECOMMENDATIONS AND "NF"=NON-FUSE
#	MANUAL DIMMER OR FAN SPEED CONTROL ("F" INDICATES FAN SPEED CONTROL)		HORIZONTAL MOUNTED DUPLEX RECEPTACLE		
#	CEILING MOUNTED OCCUPANCY SENSOR (# INDICATES FIXTURE NUMBER IN SCHEDULE)		RANGE RECEPTACLE NEMA 14-50 (125/250V 50A)	M	MOTOR
#	WALL MOUNTED OCCUPANCY SENSOR/SWITCH (# INDICATES FIXTURE NUMBER IN SCHEDULE)	W	WELDER RECEPTACLE NEMA 6-50 (250V 50A)	PB	PULL BOX
	PUSH BUTTON STATION		DOUBLE DUPLEX RECEPTACLE	J	WALL MOUNTED JUNCTION BOX
P	PHOTOCELL CEILING MOUNTED		(1) DUPLEX, (1) DUPLEX AUTOMATICALLY CONTROLLED	J #	JUNCTION BOX ("F" INDICATES FLOOR, "C" INDICATES CEILING)
P	PHOTOCELL WALL MOUNTED		ISOLATED GROUND DOUBLE DUPLEX RECEPTACLE		BRANCH CIRCUIT
	TIME SWITCH		RED DOUBLE DUPLEX RECEPTACLE		BRANCH CIRCUIT - CONCEALED BELOW FLOOR (UNDERGROUND IF EXTERIOR)
R	RELAY		RECEPTACLE IN AV BACKBOX		HOMERUN TO PANEL (NUMBER OF ARROWS INDICATES NUMBER OF CIRCUITS)
ER	EMERGENCY LIGHTING RELAY		WALL CLOCK HANGER RECEPTACLE		SPECIAL PURPOSE HOMERUN AS INDICATED
	LIGHTING CONTACTOR		CEILING MOUNTED DUPLEX RECEPTACLE		CONDUIT SEAL
#	POWER AND/OR DATA FLOOR OUTLET ("#" INDICATES DEVICE TYPE IN SCHEDULE)		CEILING MOUNTED DOUBLE DUPLEX RECEPTACLE		CIRCUIT DOWN
IP	TECHNOLOGY INFRASTRUCTURE POWER WALL MOUNTED JUNCTION BOX		CEILING MOUNTED RED DUPLEX RECEPTACLE		CIRCUIT UP
IP	TECHNOLOGY INFRASTRUCTURE POWER CEILING MOUNTED JUNCTION BOX		CEILING MOUNTED SPECIAL PURPOSE RECEPTACLE		CONDUIT STUB-OUT
TB #	COMBINATION POWER/DATA/AV TABLETOP OUTLET ("#" INDICATES DEVICE TYPE IN SCHEDULE)		CEILING MOUNTED SIMPLEX RECEPTACLE		CIRCUIT BREAK
	MULTI-OUTLET ASSEMBLY ~ LENGTH AS INDICATED		POWER FLOOR OUTLET ("#" INDICATES DEVICE TYPE IN SCHEDULE)		CORD AND PLUG
X X	MECH EQUIPMENT WITH ELEC CONNECTION SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE		RECEPTACLE IN CEILING AV BACKBOX	#	BRANCH CIRCUIT/FEEDER TAG. SEE BRANCH CIRCUIT/FEEDER SCHEDULE

FIRE DETECTION AND ALARM

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	SMOKE DETECTOR	CM	CONTROL MODULE		SPEAKER AND STROBE COMBINATION - WALL
SB / SB	SMOKE DETECTOR WITH SOUNDER BASE	MM	MONITOR MODULE	F	SPEAKER - WALL
SA / SA	SMOKE ALARM	TS	FIRE SPRINKLER VALVE TAMPER SWITCH		SPEAKER AND STROBE COMBINATION - CEILING
BT BT	BEAM SMOKE DETECTOR SYSTEM - TRANSMITTER/REFLECTOR	FS	FIRE SPRINKLER FLOW SWITCH	F	SPEAKER - CEILING
	DUCT SMOKE DETECTOR - SAMPLING TUBE TYPE	PV	FIRE SPRINKLER POST INDICATOR VALVE	FACP	FIRE ALARM CONTROL PANEL
	DUCT SMOKE DETECTOR - IN-DUCT TYPE		HORN AND STROBE COMBINATION - WALL	FAA	FIRE ALARM ANNUNCIATOR PANEL
	HEAT DETECTOR - FIXED TEMPERATURE + RATE-OF-RISE	F	HORN - WALL	FVCC	FIRE ALARM VOICE COMMAND CENTER
F / F	HEAT DETECTOR - FIXED TEMPERATURE ONLY		STROBE - WALL	F	FIRE FIGHTER'S TELEPHONE JACK
CO / CO	CARBON MONOXIDE DETECTOR		HORN AND STROBE COMBINATION - CEILING	DH	MAGNETIC DOOR HOLD OPEN
CO / CO	COMBINATION CARBON MONOXIDE/SMOKE DETECTOR	F	HORN - CEILING	FS.D. M	COMBINATION FIRE/SMOKE DAMPER
AS AS S	AIR SAMPLING SMOKE DETECTION SYSTEM		STROBE - CEILING	S.D. M	SMOKE DAMPER
SP AS	ASPIRATING SMOKE DETECTION SYSTEM - POINT ADDRESSABLE; SP = SAMPLE PORT	F	MANUAL PULL STATION	# =	INDICATES CANDELA RATING WHERE INDICATED

MISCELLANEOUS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
S	COMBINATION CLOCK / SPEAKER UNIT	C	CHIME	AQ	AQUASTAT
ARCM	AREA OF RESCUE COMMUNICATION SYSTEM MASTER UNIT	B	CHIME BUTTON	T	THERMOSTAT
ARCR	AREA OF RESCUE COMMUNICATION SYSTEM REMOTE UNIT		ELECTRIC SOLENOID VALVE		BELL
EV EV	ELECTRIC VEHICLE CHARGING STATION DASHED LINES INDICATE FUTURE				

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

GENERAL NOTES

1. INSTALL GREEN INSULATED GROUND WIRE WITH EACH LIGHTING, RECEPTACLE, AND EQUIPMENT BRANCH CIRCUIT.
2. PROVIDE A DEDICATED NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT REQUIRING A NEUTRAL, UNLESS OTHERWISE NOTED.
3. CONCEAL CONDUITS INSTALLED IN NEW WALLS, EXISTING STUD WALLS AND IN AREAS WITH SUSPENDED CEILINGS.
4. IN FINISHED AREAS WITH EXPOSED STRUCTURE, COORDINATE ROUTING OF CONDUITS AT STRUCTURE WITH OWNER. CONCEAL CONDUITS FROM VIEW AS MUCH AS POSSIBLE. CONDUIT SHALL NOT BE ROUTED PERPENDICULAR TO BOTTOM CHORD OF STRUCTURE.
5. INSTALL CONDUIT AND BOXES LOCATED NEAR METAL ROOF DECKS SO THAT THE NEAREST OUTER SURFACE OF THE CONDUIT OR BOX IS NOT LESS THAN 2 INCHES FROM THE NEAREST SURFACE OF THE ROOF DECKING. PROVIDE SPACERS AND SUPPORTS AS REQUIRED. RIGID METAL CONDUIT AND INTERMEDIATE METAL CONDUIT ARE NOT REQUIRED TO MAINTAIN THIS CLEARANCE.
6. REPAIR OR REPLACE BUILDING ELEMENTS THAT ARE DAMAGED AS PART OF ELECTRICAL WORK.
7. SPECIFICATIONS LIST ACCEPTABLE WIRING METHODS AND MATERIALS. OTHER WIRING METHODS AND MATERIALS NOT LISTED IN THE SPECIFICATIONS (SUCH AS MC CABLE, ETC.) ARE NOT ACCEPTABLE.
8. SEAL ELECTRICAL PENETRATIONS IN MECHANICAL AND ELECTRICAL ROOMS ABOVE OCCUPIED SPACES TO REDUCE NOISE TRANSMISSION.
9. SEAL PENETRATIONS IN FIRE RATED CONSTRUCTION TO MAINTAIN RATINGS.
10. UNLESS OTHERWISE INDICATED, CONNECT RECEPTACLES AND LIGHTS INTEGRAL WITH MECHANICAL UNITS TO CLOSEST RECEPTACLE CIRCUIT WITH ADEQUATE CAPACITY.

POWER GENERAL NOTES:

1. PROVIDE POWER CONNECTION TO CONTROL PANELS, TRANSFORMERS AND OTHER ITEMS FURNISHED BY MECHANICAL CONTRACTOR. COORDINATE LOCATIONS OF DEVICES REQUIRING POWER CONNECTIONS WITH MECHANICAL CONTRACTOR.
2. LABEL RECEPTACLE WALL PLATES WITH THE CORRESPONDING PANEL AND CIRCUIT NUMBER.

DEMOLITION NOTES:

1. THE OWNER SHALL HAVE FIRST SALVAGE RIGHTS TO ALL FIXTURES, DEVICES AND EQUIPMENT REMOVED. COORDINATE WITH OWNER PRIOR TO DEMOLITION.
2. WHERE EXISTING CIRCUITS ARE NOT REUSED, REMOVE CONDUCTORS AND ASSOCIATED ACCESSIBLE RACEWAYS BACK TO THE SOURCE. WHERE AN EXISTING DEVICE IS REMOVED FROM AN EXISTING CIRCUIT, PROVIDE NEW WIRING AS REQUIRED TO MAINTAIN CONTINUITY OF EXISTING CIRCUIT. UNLESS NOTED OTHERWISE, ABANDON CONCEALED CONDUITS IN WALLS WHICH ARE NOT REMOVED. WHERE AN EXISTING RACEWAY TO BE REMOVED IS STUBBED FROM A CONCRETE FLOOR OR WALL, CHISEL 2 INCHES BELOW SURFACE OF FLOOR, CUT CONDUIT, AND GROUT FLOOR TO MATCH ADJACENT SURFACE. PROVIDE BLANK PLATES FOR ABANDONED BOXES.
3. REPAIR OR REPLACE BUILDING ELEMENTS WHICH ARE DAMAGED AS PART OF DEMOLITION WORK.
4. 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.
5. DISCONNECT MECHANICAL EQUIPMENT BEING REMOVED BY MECHANICAL CONTRACTOR. COORDINATE EQUIPMENT REMOVAL LOCATIONS WITH MECHANICAL DRAWINGS.
6. 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.
7. 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.
8. REMOVE DEMOLISHED ITEMS FROM PROJECT SITE. PROPERLY DISPOSE OF ITEMS INCLUDING LAMPS AND BALLASTS.

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.

ELECTRICAL SYMBOLS, NOTES AND ABBREVIATIONS

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

HASTINGS NEBRASKA

Alvine Engineering

Omaha: 1201 Cass Street, Omaha, NE 68102, Phone: (402) 346-7007
Lincoln: 1220 Lincoln Mall, Suite 200, Lincoln, NE 68508, Phone: (402) 477-6161
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PROFESSIONAL ELECTRICAL ENGINEER SAMUEL J. HABERMAN E-14224 STATE OF NEBRASKA
CA-2169 09/30/2024

Designed	File Name
JMK	20240619E0-0
Drawn	Project No.
VG	20240619
Checked	Drawing No.
SJH	E0-0
Date	
09/20/2024	

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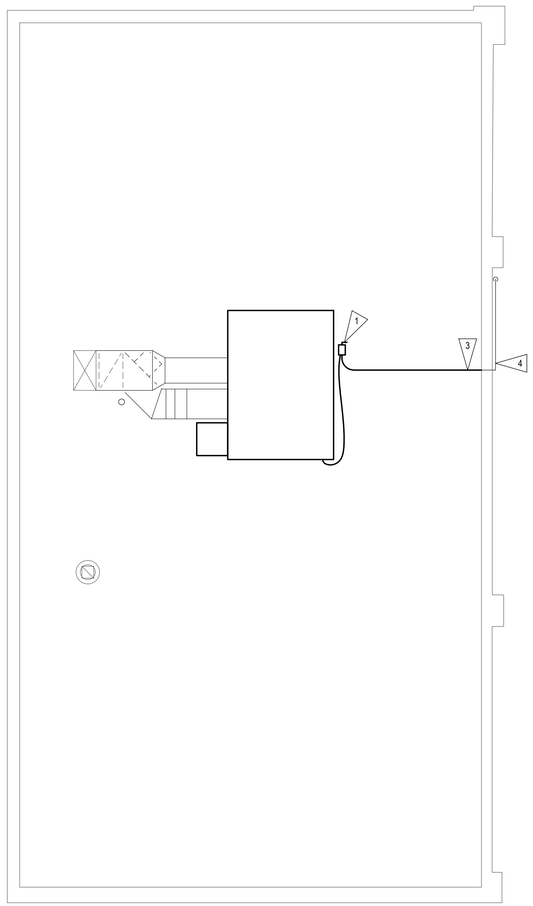
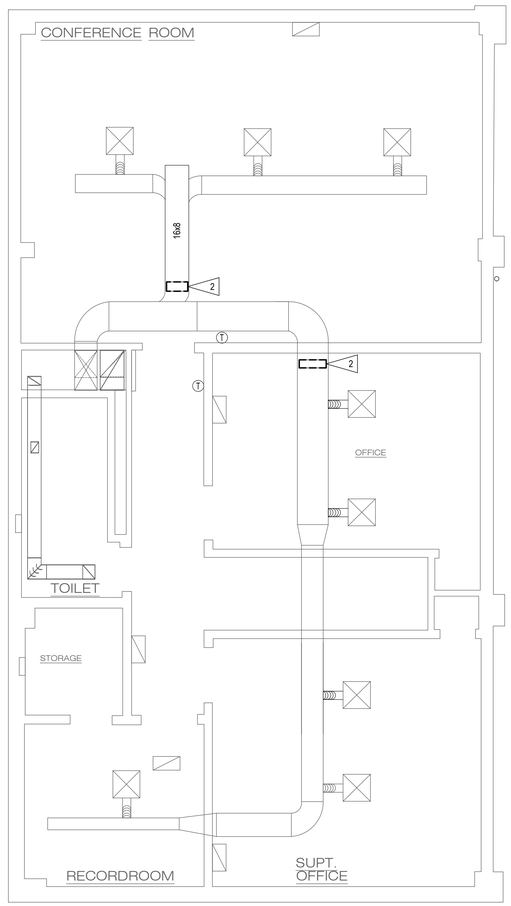


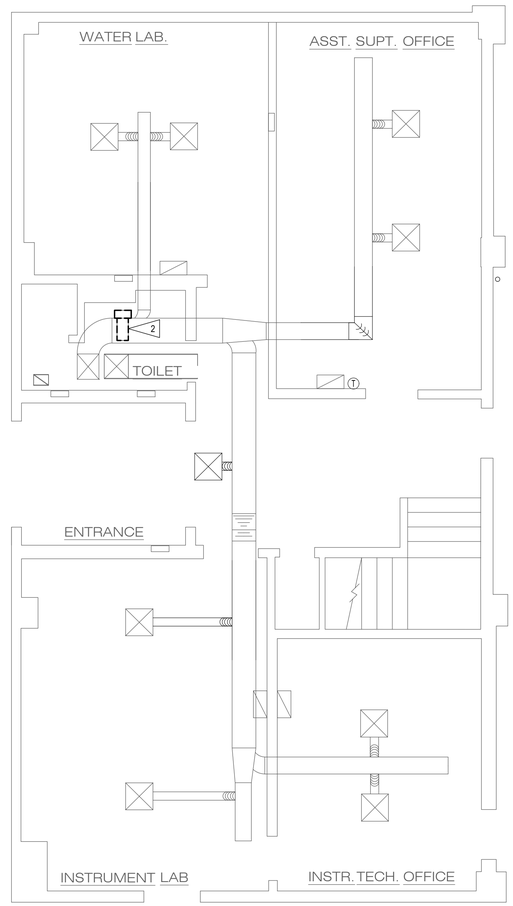
ROOF PLAN
ELECTRICAL - DEMOLITION

SCALE: 1/4" = 1'-0"



SECOND FLOOR PLAN
ELECTRICAL - DEMOLITION

SCALE: 1/4" = 1'-0"



MAIN FLOOR PLAN
ELECTRICAL - DEMOLITION

SCALE: 1/4" = 1'-0"

FLAG NOTES

1. DISCONNECT POWER TO ROOFTOP UNIT. REMOVE DISCONNECT, FLEX CONDUIT AND CONDUCTORS TO EQUIPMENT. UNIT IS FED FROM MOTOR CONTROL CENTER 'TURBINE ROOM MCC' LOCATED IN THE BASEMENT.
2. DISCONNECT POWER TO ELECTRIC DUCT HEATER. REMOVE CONDUCTORS AND CONDUIT BACK TO THE SOURCE.
3. REMOVE CONDUCTORS BACK TO SOURCE. REMOVE CONDUIT TO EXTERIOR WALL.
4. EXISTING CONDUIT INSIDE OF BUILDING TO REMAIN.

No	Revisions	Date

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ELECTRICAL
DEMOLITION

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

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ALVINE Engineering

Omaha: 1201 Cass Street, Omaha, NE 68102, Phone: (402) 346-7007
Lincoln: 1220 Lincoln Mall, Suite 200, Lincoln, NE 68508, Phone: (402) 477-6161
Oklahoma City: 1001 W. Wilshire Blvd., Suite 102, Oklahoma City, OK 73116, Phone: (405) 936-3480
Des Moines: 400 East Court Avenue, Suite 130, Des Moines, IA 50309, Phone: (515) 243-0569

PROFESSIONAL ELECTRICAL ENGINEER
SAMUEL J. HABERMAN
E-14224
STATE OF NEBRASKA

CA-2169 09/30/2024

Designed: JMK	File Name: 20240619E0-1
Drawn: VG	Project No.: 20240619
Checked: SJH	Drawing No.: E0-1
Date: 09/20/2024	

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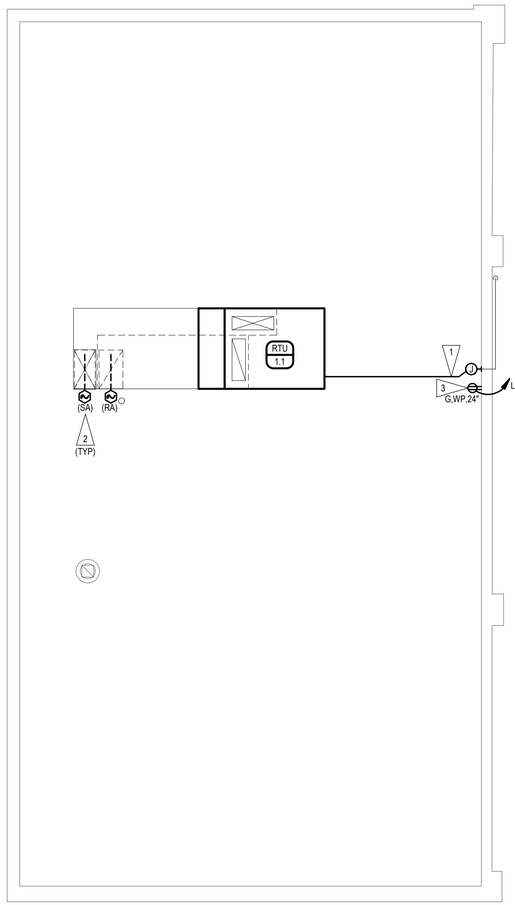
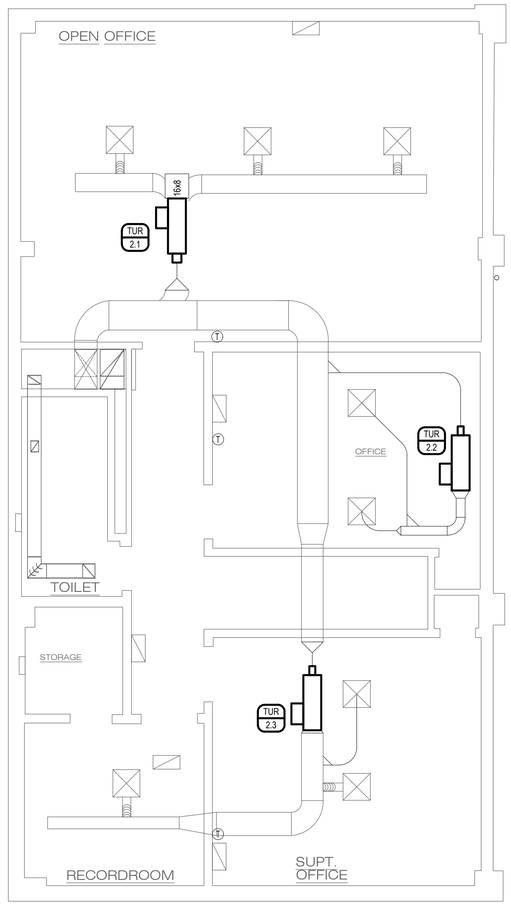


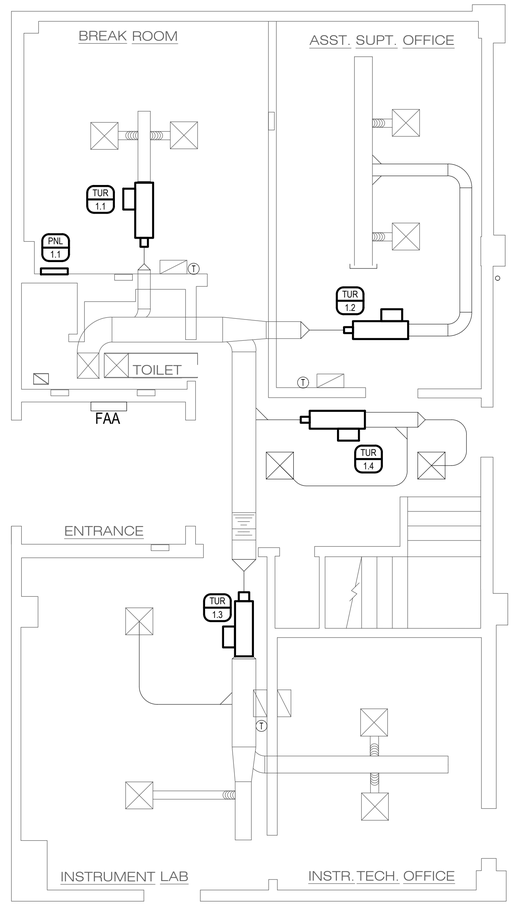
ROOF PLAN
ELECTRICAL - NEW WORK

SCALE: 1/4" = 1'-0"



SECOND FLOOR PLAN
ELECTRICAL - NEW WORK

SCALE: 1/4" = 1'-0"



MAIN FLOOR PLAN
ELECTRICAL - NEW WORK

SCALE: 1/4" = 1'-0"

FLAG NOTES

1. PROVIDE NEMA 3R PULLBOX AND ROUTE CONDUIT ACROSS ROOF TO NEW RTU. SEE MECHANICAL / ELECTRICAL COORDINATION SCHEDULE FOR FEEDER SIZE. COORDINATE ROUTING WITH MECHANICAL CONTRACTOR TO MAINTAIN EQUIPMENT WORKING CLEARANCES.
2. PROVIDE DUCT DETECTORS IN EXISTING DUCTWORK, INSTALL IN DUCTWORK BELOW ROOF. TIE IN WITH EXISTING SIEMENS FIRE ALARM SYSTEM.
3. MOUNT TO SIDE OF EXISTING WALL. VERIFY ROUTING OF CONDUIT TO NEW PANEL LOCATED IN BASEMENT. PROVIDE CAST METAL "WHILE-IN-USE" COVER.

No	Revisions	Date

ELECTRICAL
NEW WORK

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

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PROFESSIONAL ELECTRICAL ENGINEER
SAMUEL J. HABERMAN
E-14224
STATE OF NEBRASKA

CA-2169 09/30/2024

Designed: JMK	File Name: 20240619E1-1
Drawn: VG	Project No.: 20240619
Checked: SJH	Drawing No.: E1-1
Date: 09/20/2024	

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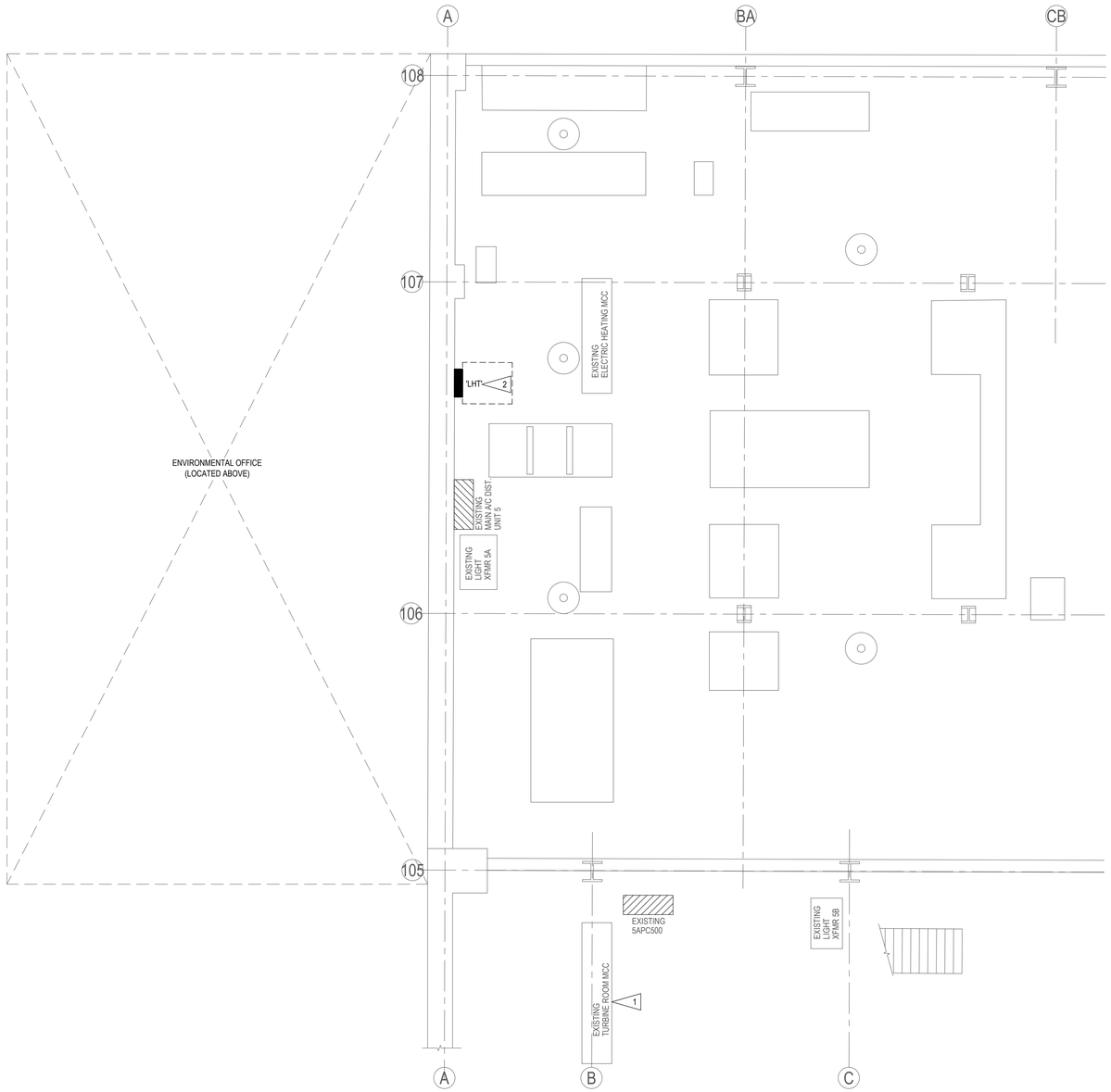


PARTIAL UNIT 5 BASEMENT
ELECTRICAL - NEW WORK

SCALE: 1/4" = 1'-0"

FLAG NOTES

1. LOCATION OF EXISTING 40/3 CIRCUIT BREAKER FOR RTU IN MCC. SEE DRAWING E2-1 FOR ADDITIONAL INFORMATION.
2. COORDINATE LOCATION OF NEW PANEL WITH OWNER.

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.

ELECTRICAL
NEW WORK

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

HASTINGS NEBRASKA

ALVINE Engineering

Omaha: 1201 Cass Street, Omaha, NE 68102, Phone: (402) 346-7202
Lincoln: 1220 Lincoln Mall, Suite 200, Lincoln, NE 68508, Phone: (402) 477-6161
Oklahoma City: 1001 W. Wilshire Blvd., Suite 102, Oklahoma City, OK 73116, Phone: (405) 936-3480
Des Moines: 400 East Court Avenue, Suite 130, Des Moines, IA 50309, Phone: (515) 243-0569

PROFESSIONAL ELECTRICAL ENGINEER
SAMUEL J. HABERMAN
E-14224
STATE OF NEBRASKA
CA-2169 09/30/2024

Designed: JMK	File Name: 20240619E1-2
Drawn: VG	Project No.: 20240619
Checked: SJH	Drawing No.: E1-2
Date: 09/20/2024	

September 30, 2024 3:35 PM Jonathan Storm

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				
W	WATTS	OS	OCCUPANCY SENSOR	EC	ELECTRICAL CONTRACTOR		
				MC	MECHANICAL CONTRACTOR		

EQUIPMENT			ELECTRICAL SYSTEM				DISCONNECT				LINE VOLTAGE CONTROLLER				
MARK	DESCRIPTION	LOAD	V	PH	FEEDER OR BRANCH CIRCUIT	PANEL - CIRCUIT	FURNISHED BY/ INSTALLED BY	TYPE	RATING (AMPS)	ENCL	FURNISHED BY/ INSTALLED BY	TYPE	ENCL	AVAILABLE FAULT CURRENT (AMPS)	REMARKS
RTU 1.1	ROOFTOP UNIT	25.3 A	480	3	40F3	EXISTING MCC	MC/-	I	-	-	MC/-	-	-		1,2
TUR 1.1	TERMINAL UNIT	3 KW	208	3	20F3	LHT-1	MC/-	I	-	-	MC/-	-	-		
TUR 1.2	TERMINAL UNIT	2 KW	208	3	20F3	LHT-7	MC/-	I	-	-	MC/-	-	-		
TUR 1.3	TERMINAL UNIT	6 KW	208	3	30F3	LHT-13	MC/-	I	-	-	MC/-	-	-		
TUR 1.4	TERMINAL UNIT	3 KW	208	3	20F3	LHT-19	MC/-	I	-	-	MC/-	-	-		
TUR 2.1	TERMINAL UNIT	5 KW	208	3	20F3	LHT-2	MC/-	I	-	-	MC/-	-	-		
TUR 2.2	TERMINAL UNIT	1.5 KW	208	3	20F3	LHT-8	MC/-	I	-	-	MC/-	-	-		
TUR 2.3	TERMINAL UNIT	4.5 KW	208	3	20F3	LHT-14	MC/-	I	-	-	MC/-	-	-		
PNL 1.1	BMCS PANEL	-	120	1	20F2	LHT-20	-	-	-	-	-	-	-		

GENERAL NOTES:

A. 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.

B. 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.

C. FRACTIONAL HORSEPOWER SINGLE PHASE MOTORS SHALL BE PROVIDED WITH INTEGRAL OVERLOAD PROTECTION.

D. DISCONNECTS SHALL BE FUSIBLE UNLESS NOTED OTHERWISE.

E. ELECTRICAL CONTRACTOR SHALL PROVIDE CIRCUIT TO EQUIPMENT AS INDICATED.

F. WHERE DISCONNECT IS NOT INDICATED ON PLANS, LOCATE AT EQUIPMENT PER NEC.

REMARKS

1 UNIT PROVIDED WITH FUSED DISCONNECT. FUSE PER MANUFACTURERS RECOMMENDATIONS.

2 CONNECT TO EXISTING 40/3 CIRCUIT BREAKER IN TURBINE ROOM MCC, LOCATED IN BASEMENT.

PANEL LHT

208/120V 3 PHASE 4 WIRE W/ GND BAR — SURFACE MOUNTED

100 AMP MLO

10,000 AIC

42 POLES ONE SECTION

DESCRIPTION	LOAD VA	REMARKS	O/C	CKT #	PH	CKT #	O/C	REMARKS	LOAD VA	DESCRIPTION
TUR-1.1	3000		15/3	1	A	2	20/3		5000	TUR-2.1
-			-	3	B	4	-			-
-			-	5	C	6	-			-
TUR-1.2	2000		15/3	7	A	8	15/3		1500	TUR-2.2
-			-	9	B	10	-			-
-			-	11	C	12	-			-
TUR-1.3	6000		25/3	13	A	14	20/3		4500	TUR-2.3
-			-	15	B	16	-			-
-			-	17	C	18	-			-
TUR-1.4	3000		15/3	19	A	20	20/1		600	PNL-1.1
-			-	21	B	22	20/1		180	ROOF RECEPTACLE
-			-	23	C	24	20/1			SPARE
SPARE			20/1	25	A	26	20/1			SPARE
SPARE			20/1	27	B	28	20/1			SPARE
				29	C	30				
				31	A	32				
				33	B	34				
				35	C	36				
				37	A	38				
				39	B	40				
				41	C	42				

LOAD TYPE	CONNECTED	DEMAND FACTOR	DEMAND		25780	EMD	
RECEPT	180	NEC	180		0	0%	SPARE
LIGHTING	0	125%	0		25780	TOTAL VA	
MISC	0	100%	0		72	MIN. FEEDER AMPS	
MTR/HTR	25600	100%	25600				

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.
40F2	2 #8, #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.
	4 WIRE PLUS GROUND
100F4	4 #2, #8 GND. 1-1/4" C.

TURBINE ROOM MCC (480V)

BUCKET	DESCRIPTION	STATUS	REMARKS
1-1	TURNING GEAR OIL PUMP	ON	
1-2	BEARING DRAIN EXHAUST	ON	
1-3	GLAND STEM COND EXHAUST	ON	
1-4	TURNING GEAR	ON	
1-5	VAPOR EXTRACTOR	ON	
2-1	WEST SCANNER AIR PUMP	ON	
2-2	TURBINE BASEMENT VENT FAN	ON	
2-3	TURBINE ROOM FAN NO 3	ON	
2-4	TURBINE ROOM FAN NO 4	ON	
2-5	UNASSIGNED	OFF - LOCKED	
3-1A	UNKNOWN - VERIFY	ON	
3-1B	TURBINE OIL PURIFIER HEATER	OFF - LOCKED	
3-2A	AUX FEED UNIT AUX TRANSFORMER	ON	
3-2B	TURBINE OIL PURIFIER	OFF - LOCKED	
3-3A	OFFICE AIR CONDITIONER (40A 3P)	ON	1
3-3B	SOUTH BATTERY CHARGER	OFF	
3-4	SOUTH ELECTRIC BOILDER FEED PUMP	ON	
3-5	BLANK	-	
4-1	UNASSIGNED	OFF - LOCKED	
4-2	UNASSIGNED	OFF - LOCKED	
4-3A	UNASSIGNED	OFF - LOCKED	
4-3B	CONTROL PWR TRANSFORMER 5A	ON	
4-4	BLANK	-	
5-1	BLANK	-	
5-2	FEED FOR 5APC500 480V AC	ON	
5-3A	CU 2A-2B COMPRESSORS	ON	
5-3B	AHU-2 CNTRL ROOM DUCT HEATER	ON	

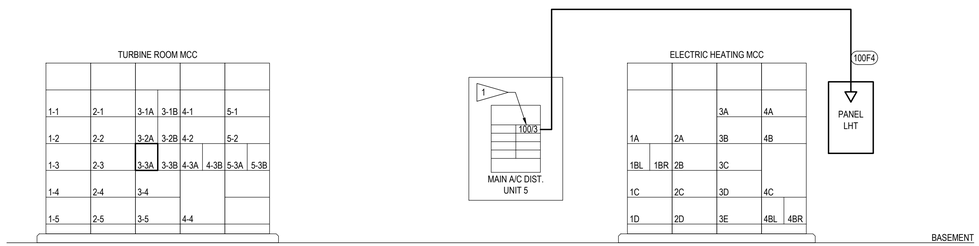
REMARKS

1. EXISTING CIRCUIT BREAKER / BUCKET TO BE REUSED FOR NEW RTU.

ELECTRIC HEATING MCC (208V)

BUCKET	DESCRIPTION	STATUS	REMARKS
1A	MAIN FEED BREAKER	OFF	
1BL	TOILETS VEST & MAP STORAGE	ON	
1BR	UNKNOWN - VERIFY	OFF	
1C	WATER LABORATORY	ON	
1D	BLANK	-	
2A	RESERVE FEED BREAKER	ON	
2B	ASSISTANT SUPT. OFFICE	OFF - LOCKED	
2C	ENTRY	ON	
2D	BLANK	-	
3A	RECORD ROOM	OFF - LOCKED	
3B	SUPT. OFFICE	OFF	
3C	OFFICE	OFF - LOCKED	
3D	INSTRUMENT TECHNICIAN OFFICE	ON	
3E	BLANK	-	
4A	CONFERENCE ROOM	OFF - LOCKED	
4B	INSTR. LABORATORY	ON	
4C	PIPE FREEZE PROTECTION	OFF - LOCKED	
4DL	UNKNOWN - VERIFY	OFF	
4DR	UNKNOWN - VERIFY	OFF	

NOTE: SCHEDULE SHOWN FOR INFORMATIONAL PURPOSE ONLY.



PARTIAL POWER RISER DIAGRAM

NOT TO SCALE

1 / E2-1

FLAG NOTES

1 CONNECT TO EXISTING SPARE CIRCUIT BREAKER.

No	Revisions	Date

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ELECTRICAL DETAILS AND SCHEDULES

CITY OF HASTINGS
ENVIRONMENTAL OFFICE
RTU REPLACEMENT

HASTINGS NEBRASKA

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SAMUEL J. HABERMAN
E-14224
STATE OF NEBRASKA
CA-2169 09/30/2024

Designed	JMK
Drawn	VG
Checked	SJH
Date	09/20/2024
File Name	20240619E2-1
Project No.	20240619
Drawing No.	E2-1

September 30, 2024 3:55 PM Jonathan Storm

Specifications

City of Hastings Environmental Office Rooftop Unit Replacement

Hastings, Nebraska

Alvine No. 2024 0619
September 30, 2024

ALVINE Engineering

402.346.7007
www.alvine.com

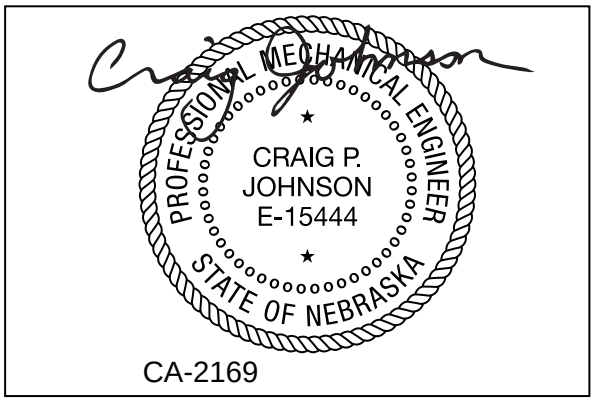
Specifications
Construction Documents

Alvine Engineering

City of Hastings
Environmental Office
Rooftop Unit Replacement

Hastings, Nebraska

Alvine No. 2024 0619



September 30, 2024

09/30/2024
I, Craig Johnson, am the Coordinating Professional for the City of Hastings Environmental Office RTU Replacement project.

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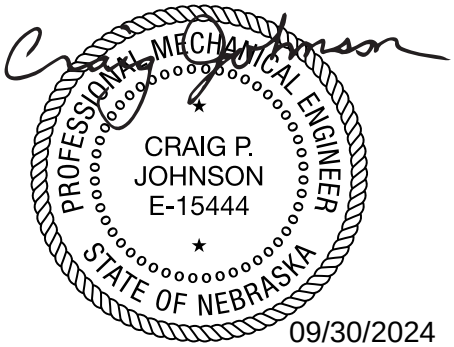


09/30/2024

CA-2169

SECTION 23 04 00

COMMON REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. 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. Uniform Plumbing Code(UPC)
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. Factory Mutual Global Engineering (FMG)
13. American Gas Association (AGA)
14. Underwriters' Laboratories, Inc. (UL)
15. National Electrical Safety Code (NESC)
16. 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.

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 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.
   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 SHORT-CIRCUIT CURRENT RATING (SCCR) FOR EQUIPMENT AND ASSOCIATED CONTROL PANELS

A. SCCR Compliance - Equipment manufacturers and suppliers shall provide a certified SCCR for all equipment and associated panels to be provided with equipment procured under these specifications. The certified SCCR rating shall be no less than the value of the available fault current at the switchboard or panel serving the equipment as indicated on the Division 26 Electrical Riser Diagrams. Manufacturer shall provide internal components that meet or exceed the SCCR rating required by these specifications. Manufacturer shall refer to the National Electrical Code (NEC), which is also known as NFPA 70, Article 100 for additional requirements

B. Supplemental SCCR Compliance Data - At the manufactures option, they may calculate the available fault current at the specific equipment connection point. Manufacturer shall obtain feeder size, breaker type and length of feeder from the Division 26 contractor. All calculations shall be submitted as part of the equipment submittal for review by the engineer.

C. Application of Labels - All equipment and control panels associated with equipment procured under these specifications shall have a permanently installed label provided by the manufacturer as a part of the equipment indicating the SCCR rating of the equipment. Labels shall comply with NEC Article 409 - Industrial Control Panels, and NEC Article 670 - Industrial Machinery.

2.3 CONTROL SYSTEM INTERFACES

A. Equipment and systems shall be able to interface and integrate to BMCS systems and sequences via vendor protocols including, as a minimum, BACnet, LonTalk and Modbus.

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 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.

2.8 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. 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. HVAC Controls (Including but not limited to):
   a. Manufacturer's Packaged Control Systems
   b. Air Terminal Units
   c. Transmitters
2. Packaged Rooftop Units

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 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. 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. Carbon dioxide (CO_2) 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 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 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, floors, etc.) and openings are modified, removed and/or replaced to accommodate the new work or to introduce into or remove items from the building, such surfaces or openings shall be carefully reinstalled 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.

3.14 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. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   4. 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.

3.15 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 sizeductwork and calculate friction loss 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 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 in walls, pipe chases, utility chases, above ceilings, below grade or floors, unless otherwise noted, except in mechanical rooms or service areas.
10. Install ductwork to allow application of insulation plus 1-inch clearance around insulation.
11. Provide components with pressure rating equal to or greater than system operating pressure.
12. Install fittings for changes in direction and branch connections.
13. Install piping free of sags or bends with ample space between piping to permit proper insulation applications.
14. 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.
15. 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.
16. Do not use ceiling support system to bear weight of devices or systems unless ceiling support system is certified as suitable to do so.
17. During construction, avoid any undue loads, forces or strains on valves, equipment, pumps flanges, or building elements with piping connections or piping systems.
18. Keep all duct and equipment openings closed during construction except when actual work is being performed on that item or system.

C. Contractor is responsible for any cutting and patching needed for mechanical installation. Patching must match existing.

D. Verify final equipment locations for roughing-in of all systems.

3.16 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.

3.17 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."

3.18 INCIDENTAL WORK

A. The following incidental work shall be furnished by the designated contractor under the supervision of the Temperature Control Contractor:
   1. The Air Distribution Contractor shall install all automatic dampers furnished by the Temperature Control Contractor.
   2. The Air Distribution Contractor shall provide necessary blank-off plates (safing) required to install dampers that are smaller than duct size.
   3. The Air Distribution Contractor shall provide access doors or other approved means of access through ducts for service to control equipment.

3.19 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.

3.20 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. 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.
5. Test ductwork systems per SMACNA and applicable codes and standards.
6. Submit all test reports to the Engineer for review prior to date of substantial completion.
7. 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. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

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. Rooftop Units: Nameplates.

B. Air Terminal Units: Nameplates.

C. Control Panels: Nameplates.

2.2 NAMEPLATES

A. Manufacturers:
   1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com.
   2. Brimar Industries, Inc.: www.pipemarker.com.
   3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
   4. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
   5. Seton Identification Products, a Tricor Direct Company: www.seton.com.

B. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.
   2. Letter Height: 1/2 inch (13 mm).
   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 NAME PLATES

A. Install plastic name plates with the manufacturer's recommended adhesive.

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. 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; 2016.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008, with Errata (2019).

C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems; 2015, with Errata (2017).

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

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, 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) Terminal flow calibration (for each terminal type).
    2) Diffuser proportioning.
    3) Branch/submain proportioning.
    4) Total flow calculations.
    5) Rechecking.
    6) Diversity issues.
h. Expected problems and solutions, etc.
i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
j. 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.
k. Specific procedures that will ensure that both air side systems are operating at the lowest possible pressures and methods to verify this.
l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
n. Method of checking building static and exhaust fan and/or relief damper capacity.
o. Proposed selection points for sound measurements and sound measurement methods.
p. Methods for making coil or other system plant capacity measurements, if specified.
q. Time schedule for TAB work to be done in phases (by floor, etc.).
r. Description of TAB work for areas to be built out later, if any.
s. Time schedule for deferred or seasonal TAB work, if specified.
t. False loading of systems to complete TAB work, if specified.
u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
v. Interstitial cavity differential pressure measurements and calculations, if specified.
w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
x. Procedures for formal progress reports, including scope and frequency.
y. 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 dampers, and balancing dampers.

E. As-Balanced Record Fan Curves: Record actual balanced points on the manufacture's submitted fan curves.
1. Record system curves and actual RPM data for all fans.
2. Record system curves, actual RPM and final impeller diameter for all pumps.

F. 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 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.
   12. Balancing dampers and devices are installed.

B. Examine equipment performance data including fan 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 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 plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

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 and other controlled devices are operated by the intended controller.
   3. Dampers are in the position indicated by the controller.
   4. Integrity of ampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in variable-air-volume terminals.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. 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.
   8. Changeover from heating to cooling mode occurs according to indicated values.
   9. Transmitter and controller locations and note conditions that would adversely affect control functions.
   10. Operation of limiting controllers (i.e., high- and low-temperature controllers).
   11. Free travel and proper operation of control devices such as damper and valve operators.
   12. Interaction of electrically operated switch transducers.
   13. Interaction of interlock and lockout systems.
   14. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
   15. 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.

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 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 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.

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. Measure air quantities at air inlets and outlets.

J. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

K. 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.

L. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

M. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

N. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

O. 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.

P. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

Q. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

R. 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.

S. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.

T. On electric heating coils, adjust system to provide required minimum airflow or downstream pressure differential to activate controls.

U. 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 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. Packaged Roof Top Heating/Cooling Units.
2. Restroom Exhaust Fan.
3. Variable Air Volume Terminal Units.
4. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

A. Packaged Roof Top Heating/Cooling Units:
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.

B. Supply and Power Exhaust 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. Fan RPM.

C. 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.

D. Exhaust Fans:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

E. 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.

F. 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.

G. Air Distribution Tests:
1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.

7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

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

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; 2021.

B. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.

E. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

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, UL 723, ASTM E84, or UL 723.

B. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Insulation products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.

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, FLEXIBLE

A. Manufacturer:
1. CertainTeed Corporation: www.certainteed.com.
2. Johns Manville Corporation; : www.jm.com.
3. JP Lamborn Co: www.jpflex.com.
4. Knauf Insulation: www.knaufinsulation.com.
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 (0.029 ng/(Pa s m)), 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.
2. Johns Manville Corporation; : www.jm.com.
3. Knauf Insulation: www.knaufinsulation.com.
4. Manson Insulation, Inc.: www.mansoninsulation.com
5. Owens Corning Corporation: www.ocbuildingspec.com.

B. Insulation: ASTM C 612; rigid, noncombustible board.
1. K (Ksi) Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F (232 degrees C).
3. Maximum Water Vapor Absorption: 5.0 percent.
4. Maximum Density: 8.0 pcf (128 kg/cu m).

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 (0.029 ng/(Pa s m)), 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 (305 g/sq m) 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. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
6. 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.

7. 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. Existing supply air ductwork that has existing duct wrap insulation or liner.
a. Note: All new supply air ductwork shall be insulated. Uninsulated existing ductwork connecting to the new ductwork shall be insulated.

2. Existing ductwork concealed in chases.
3. Fibrous-glass ducts.
4. Factory-insulated flexible ducts.
5. Factory-insulated plenums and casings.
6. Factory-insulated rooftop unit curbs.
7. Flexible connectors.
8. Vibration-control devices.
9. 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 Blanket: 2.2 inches thick and 0.75-lb/cu. ft. nominal density.
   2. Return Air:
      a. None.

END OF SECTION

SECTION 23 09 13.13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Control panels.

B. Power Supplies and Transformers.

C. Low Voltage Control Cable.

D. Input/Output Sensors:
1. Temperature sensors.
2. Humidity sensors.
3. Static pressure (air pressure) sensors.
4. Equipment operation (current) sensors.
5. Damper position indicators.

E. Transmitters:
1. Building static pressure transmitters.
2. Air pressure transmitters.
3. Water pressure transmitters (liquid differential pressure transmitters).

F. Output Devices.

1.2 REFERENCE STANDARDS

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

B. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

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. Control panel interior layout drawings indicating the following:
    a. Overall panel size.
    b. Device loactions and labeling within panel.
    c. Spare and space locations.
    d. Power supplies and transformers.
    e. Wiring and cabeling pathways.
6. Clearly note the proposed deviations from specified sequences and equipment, and substantiate with written explanation.

D. Samples: Submit two of each type of room thermostat and cover.

E. Design Data: Provide design data for sizing and selection of compressor.

F. Manufacturer's Instructions: Provide for all manufactured components.

G. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

H. 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.

I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

J. 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 Thermostats and Other Exposed Sensors: One of each type.

1.5 QUALITY ASSURANCE

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

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience approved by manufacturer.

D. 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 total 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.

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. {\rs\#1}, 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.
5. A convenience 120 VAC duplex receptacle, fused on/off power switch, and required transformers shall be provided in each enclosure.

2.4 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 compoenets unless properly shielded.

C. DDC Power Supply Panel with Transformers:
1. Transformer: 500 VA
2. Over Current Protection: Circuit Breaker
3. Primary: 480/277/240/120 VAC
4. Frequency: 50/60 Hz
5. Nominal Dimensions: 12" x 12" x 6"
6. Approvals: Class 2 (UL Approved UL5085-3), UL916, UL508, C-UL, CE, RoHS
7. Housing: NEMA1 Metal Enclosure, Plenum Rated
8. Weight: 30.16 lbs.
9. 5 Secondaries: 24 VAC, with LED Indicators
10. 24 VAC ON/OFF: On / Off Switch & Breaker
11. Input: 480/277/240/120 VAC, Finger-Safe Terminals
12. Output: 5 Isolated, Floating 100 VA Class 2 24 Vac Terminals
13. Ambient Temperature Derating: 4A up to 40 degrees C; 3A up to 50 degrees C ; 2A up to 55 degrees C (When All 5 Outputs Operated Simultaneously)
14. Standby Wattage: 48.5 W @ 120 VAC
15. Full Load Primary Current: 4.6 A @ 120 VAC
16. Basis of Design: Functional Devices, Inc. Model no.: PSH500A, Enclosed Power Supply

D. Uninterruptable Emergency Power Supplies (UPS):
1. Output:
    a. Output Power Capacity: 1920 Watts / 1920 VA
    b. Max Configurable Power: 1980 Watts / 2200 VA
    c. Nominal Output Voltage: 120V
    d. Output Voltage Distortion: Less than 5%
    e. Output Frequency (sync to mains): 50/60Hz +/- 3 Hz
    f. Topology: Line Interactive
    g. Waveform Type: Sine wave
    h. Output Connections: (8) NEMA 5-15R, (2) NEMA 5-20R
2. Input:
    a. Nominal Input Voltage: 120V
    b. Input Frequency: 50/60 Hz +/- 3 Hz (auto sensing)

c. Input Connections: NEMA 5-20P
d. Cord Length: 6 feet (1.83 meters)
e. Input voltage range for main operations: 82 - 144V
f. Input voltage adjustable range for mains operation: 75 - 154V

3. Batteries & Runtime:
   a. Battery Type: Maintenance-free sealed Lead-Acid battery with suspended electrolyte : leakproof
   b. Typical recharge time: 3 hour(s)
4. Energy Use/Efficiency:

	Load	Efficiency
a.		
b.	25%	97.4%
c.	50%	98.2%
d.	75%	98.2%
e.	100%	98.1%

5. Communications & Management:
   a. Interface Port(s): (1) SmartSlot
   b. Control panel: Multi-function LCD status and control console
   c. Audible Alarm: Alarm when on battery : distinctive low battery alarm : configurable delays
   d. Emergency Power Off (EPO)
6. Surge Protection and Filtering:
   a. Surge energy rating: 530 Joules
   b. Filtering: Full time multi-pole noise filtering : 0.3% IEEE surge let-through : zero clamping response time : meets UL 1449
7. Environmental:
   a. Operating Environment: 32 - 104 °F
   b. Operating Relative Humidity: 0 - 95%
   c. Operating Elevation: 0-10000 feet
   d. Storage Temperature: 5 - 113 °F
   e. Storage Relative Humidity: 0 - 95%
   f. Storage Elevation: 0-50000 feet
   g. Audible noise at 1 meter from surface of unit: 45.00 dBA
   h. Online Thermal Dissipation: 275.00 BTU/h
8. Conformance:
   a. Regulatory Approvals: CSA, ENERGY STAR (USA), FCC Part 15 Class A, UL 1778
   b. Standard Warranty: 3 years repair or replace (excluding battery) and 2 year for battery, optional on-site warranties available, optional extended warranties available

2.5 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.

2.6 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 (26 degrees C).
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 (0.28 degrees C) minimum.
2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
3) Chilled Water Accuracy: Plus/minus 0.50 degrees F (0.28 degrees C) minimum.
4) All Other Accuracy: Plus/minus 0.75 degrees F (0.42 degrees C) minimum.
5) Range: Minus 40 degrees F (Minus 40 degrees C) through 220 degrees F (104.4 degrees C) minimum.
b. Thermistor:
1) Accuracy (All): Plus/minus 0.36 degrees F (0.20 degrees C) minimum.
2) Range: Minus 25 degrees F (Minus 13 degrees C) through 122 degrees F (50 degrees C) minimum.
3) Heat Dissipation Constant: 2.7 mW per degree C.
c. Temperature Transmitter:

1) Accuracy: 0.10 degree F (0.06 degrees C) 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 (minus 34.4 degrees) to 230 degrees F (114.4 degrees C).
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 (0.56 degrees C) or use temperature transmitter when offset is greater than 1.0 degree F (0.56 degrees C) 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 Security Sensors: Stainless steel cover plate with insulated back and security screws.

j. Room Temperature Sensors with Integral Digital Display:
1) Construct for surface or wall box.
2) Provide a keypad with the following capabilities:
(a) Indication of space temperature.
(b) Setpoint adjustment to accommodate room setpoint.
(c) Manual occupancy override and indication of occupancy status.

k. Temperature Averaging Elements:
1) Use on duct sensors for ductwork 10 sq ft (0.93 sq m) or larger.
2) Use averaging elements where prone to stratification with sensor length 8 ft (2.5 m) or 16 ft (5 m).
3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.

l. Insertion Elements:
1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches (1 sq m).

2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches (60 mm).

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 (25 degrees C), 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 (Plus/minus 0.10 percent per degree C).
2) Outdoor Mounted: 4 to 20mA version: (0.0013x%RHx(TdegreeC-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 (Plus/minus 1.3 degrees C).
(b) HD Transmitter Accuracy: Plus/minus 1.0 degree F (Plus/minus 0.5 degrees C).
l. Operating Environment:
1) Operating Humidity Range: 0 to 100 percent RH noncondensing.
2) Operating Temperature Range: Minus 40 degrees F (Minus 40 degrees C) to 122 degrees F (50 degrees C).
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 (5 to 40 degrees C).

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 (0 to 1250 Pa).
2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi (50 to 400 kPa).
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.

2.7 TRANSMITTERS

A. Building Static Pressure Transmitters:
1. One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg (.0025 to 1.5 kPa) positive or negative, and sensitivity of 0.0005 inch wg (0.125 Pa). 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 (20.6 kPa).
i. Burst Pressure (pressure differential): 5 psid (34.5 kPa).
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. (250 Pa): 2.0 percent per degree C.
2) 10 inch w.c. (2.5 kPa): 0.01 percent per degree C.; (Relative to 25 degrees C) 32 degrees F (0 degrees C) to 122 degrees F (50 degrees C).
l. Zero Drift (1-year) (per transmitter size):
1) 1 inch w.c. (250 Pa): 2 percent maximum.
2) 10 inch (2.5 kPa): 0.05 percent maximum.

m. Zero adjust: Pushbutton auto-zero and digital input (2-pos terminal block).

n. Operating Environment:

1) 32 degrees F (0 degrees C) to 140 degrees F (60 degrees C).

2) 0 to 90 percent RH noncondensing.

o. Fittings:

1) Brass barb.

2) 0.24 inches (6.1 mm) outer diameter.

3) {\rs\#1} 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 (25 degrees C) for less than or equal 20 ft (6.1 m):

(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 (28 BSP) female thread, stainless steel 17 to 4 PH.

f. Pressure Ranges:

1) 0 psi (0 kPa) to 50 psi (345 kPa) (Gauge): 5 psid (34.5 kPa)/10 psid (68.9 kPa)/25 psid (172.4 kPa)/50 psid (344.7 kPa) (pressure differential).

2) 0 psi (0 kPa) to 100 psi (690 kPa) (Gauge): 10 psid (68.9 kPa)/20 psid (137.9 kPa)/50 psid (344.7 kPa)/100 psid (689.5 kPa) (pressure differential).

3) 0 psi (0 kPa) to 250 psi (1724 kPa) (Gauge): 25 psid (172.4 kPa)/50 psid (172.4 kPa)/125 psid (861.8 kPa)/250 psid (1723.7 kPa) (pressure differential).

g. Operating Conditions:

1) Temperature Compensated Range:

(a) 32 degrees F (0 degrees C).

(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 (Minus 20 degrees C) to 185 degrees F (85 degrees C).

3) Operating Environment: 14 degrees F (Minus 10 degrees C) to 122 degrees F (50 degrees C); 10 to 90 percent RH noncondensing.

h. Enclosure: {\rs\#1}, Type 4.

i. Bypass manifold or 3-valve manifold for service and commissioning.

2.8 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.

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 (1200 mm) above floor. Align with lighting switches and humidistats. Refer to Section 26 27 26.

C. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

D. 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.

E. Provide valves with position indicators and with pilot positioners where sequenced with other controls.

F. 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.

G. 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. 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. Coordinate required 120V power circuits and LAN outlets with Electrical Contractor.

C. Incidental control wiring includes but not limited to:
   1. HVAC Controls (Including but not limited to):
      a. Manufacturer's Packaged Control Systems
      b. Control Relays
      c. Air Terminal Units
   2. Packaged Rooftop Units

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 indentification 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.

END OF SECTION

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Control System Interfaces

B. System description.

C. Controllers.

D. Power supplies and line filtering.

E. System software.

F. Controller software.

G. HVAC control programs.

1.2 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata and Amendments (2022).

B. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2022h, with Editorial Revision.

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

D. UL (DIR) - Online Certifications Directory; Current Edition.

1.3 DEFINITIONS

A. BMCS: The complete building management and direct-digital control (DDC) system described in this specification section.

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. System shall fully support a multi-vendor environment and be able to interface and integrate third party systems via vendor protocols including, as a minimum, BACnet, LonTalk and Modbus.

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 BMCS network and final coordination of all Sequences of Operation.
   3. The meeting(s) shall include the Owner's Representative and Commissioning Authority.
   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. Manufacturer's packaged system control panels.
   2. Roof-Top Units.
   3. Variable Air Volume Terminal Units.
   4. Energy Recovery Ventilators and 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 1.3 (August 2018)
   2. Enviromental Security Technology Certification Program (ESTCP) Cybersecurity Guidelines
   3. Niagara Hardening Guide
      a. Using a VPN with Niagara Systems
   4. Security in Internet-Connected Building Automation and Energy Management System
      a. http://www.incenergy.com/sites/default/files/Security%20WhitepaperBranded.pdf

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 a proven record of experience in the supply and installation of equivalent systems over a minimum period of five years. Document at least three and no more than six projects of equal or greater size and complexity.
   3. Have been a factory-certified representative for the BMCS manufacturer for a minimum of three years for design, installation, and maintenance of the proposed systems.
   4. Have comprehensive local service and support facilities for the total BMCS as provided.
   5. 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. Automated Logic: www.automatedlogic.com.
   1. WebCTRL.

B. Honeywell: www.honeywell.com.
   1. ComfortPoint.

C. Johnson Controls, Inc.: www.johnsoncontrols.com.
   1. Verasys: www.verasyscontrols.com.

D. Schneider Electric: www.se.com/us/en/
   1. SpaceLogic Ready-Server.

E. 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 terminals, reheat 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, 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 rooftop units, air terminal units, and electric reheat coils.

2.3 OPERATOR FUNCTIONS - WEB-BASED BMCS

A. Operators shall have access to specific functions of the BMCS via a standard web browser interface, subject to password access assigned by the Owner. The web-based displays shall be XML based. The web-based access shall present information to the operators and tenants to accomplish the following:
   1. Tenants with low-level passwords shall be able to:
      a. Enter a start time, duration, and designate lighting only or HVAC/Lighting to start for after-hour service. Provide a report to show current charges for these after-hour services for each tenant on a zone-by-zone basis.
      b. Zone Setpoint Changes: These shall be constrained within an operator-determined value which shall be set initially at + and - 2 degrees F.
   2. Operators with the appropriate level and password shall be able to perform all specified functions specified in these documents.

B. All operator entries shall be coordinated with the BMCS to ensure seamless operations and tracking of all changes to history and archive databases.

C. System must support Android and Iphone access with support for mobile and tablet applications.

D. Operator must have access to all editing software from any browser. Available software must be imbedded on controller to support editing and sub-controller access if applicable.

E. Operator access shall not require the use of JAVA to access the Web Based user interface.

F. Provide all necessary web page creations, user name and passwords, and configurations to fully implement this feature for 200 users.

G. BMCS Security

1. General Security
    a. All internet facing user interface allowing remote access shall be placed behind a firewall or VPN.
    b. Consult with local IT staff for preferred method and verification of IT security policies.
    c. Contractor shall be responsible for a securable interface.
    d. User interface , if not directly protected by owner IT infrastructure security policies shall update security definitions on a regular basis. No less than once per week.
    e. Access from remote source shall be secured by HTTPS Hyper Text Transfer Protocol over SSL (Secure Socket Layer).
        1) An SSL Certificate shall be provided at no additional cost to the owner.
    f. Default credentials that are used to set up software shall not be available after installation.
    g. Disable FTP, Telnet, and any other services that may deem the system “unsecure”.
    h. Disable services that will not be used.
    i. Software updates shall be performed regularly.
    j. Contractor / vendor shall hold liability for all “third-party” software including graphics builders, software for sub-controllers, tech-support access, contractor admin / billing.
    k. All external memory required or used on-site shall be verified by local IT staff to be safe before being used on owner network.
    l. All laptops and workstations being added to the owners network must be approved and cleared before being added to the network.
    m. IP addresses shall be approved and provided by local IT staff.
2. Installation Security
    a. Install supervisory controller(s) in locked area with restricted access.
3. User Security
    a. Passwords:
        1) “Strong Password” functionality shall be available.
        2) Passwords shall expire after 90 days.
        3) A 15 day warning period of expiration shall be used.
        4) User password reset shall be available.
        5) Password history of 5 shall be enabled.
    b. Account lockout feature shall be used with a 30 second lockout period.
    c. 10 Maximum logins before lockout with a 5 minute lockout window.
    d. All lockout features shall be approved by local IT staff.
    e. Use a different account for each user.
    f. Use unique service type accounts(admin, user, view only, etc).
    g. Install read-only remote accessible account for design team and commissioning authority.
4. Applicable Security Standards and Reference Guides:
    a. Transport Layer Security (TLS) TLS 1.3 (August 2018)
    b. Enviromental Security Technology Certification Program (ESTCP) Cybersecurity Guidelines
    c. Niagara Hardening Guide

d. Using a VPN with Niagara Systems
e. Security in Internet-Connected Building Automation and Energy Management System
1) http://www.incenergy.com/sites/default/files/Security%20WhitepaperBranded.pdf

2.4 CONTROLLERS AND PANELS

A. Primary DDC panels as follows:
1. Minimum one (1) BMCS system Primary DDC panel per two floors. The application specific controllers installed for the terminal units on a floor will be connected to the nearest BMCS pane.
2. It shall be acceptable to combine up to three (3) of the following mechanical equipment into one (1) BMCS system Primary DDC panel:
a. Variable Air Volume Terminal Units
b. Package Rooftop Units

B. Building Controllers
1. General:
a. Controls shall be BTL listed.
b. All binary/digital outputs must have LED status.
c. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
d. Provide sufficient memory to support controller's operating system, database, and programming requirements.
e. Share data between networked controllers.
f. 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.
g. Utilize real-time clock for scheduling.
h. Continuously check processor status and memory circuits for abnormal operation.
i. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
j. Communication with other network devices to be based on assigned protocol.
k. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required.
l. Provide control unit's with minimum 30 percent spare capacity.
m. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
n. 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.
o. 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.

p. 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).

q. 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.

r. Controller local display and adjustment panel: Portable control unit, containing digital display, and numerical keyboard. Display and adjust:
1) Input/output point information and status.
2) Controller set points.
3) Controller tuning constants.
4) Program execution times.
5) High and low limit values.
6) Limit differential.
7) Set/display date and time.
8) Control outputs connected to the network.
9) Automatic control outputs.
10) Perform control unit diagnostic testing.
11) Points in "Test" mode.

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 (4 to 65 degrees C).

b. Conditioned Space:
1) Mount within dustproof enclosures.
2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

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 (1 m).

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 (4 to 65 degrees C).

b. Conditioned Space:
1) Mount within dustproof enclosures.
2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

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 (1 m).

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 (4 to 65 degrees C).
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
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 (1 m).

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.

2.5 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 (0 to 50 degrees C).
   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. Power Line Filtering:
   1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
   2. Minimum surge protection attributes:
      a. Dielectric strength of 1000 volts minimum.
      b. Response time of 10 nanoseconds or less.
      c. Transverse mode noise attenuation of 65 dB or greater.
      d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

C. Control Unit Battery Back-up:
   1. For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.

2.6 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.

2.7 SYSTEM SOFTWARE

A. General:
1. Include all software required to service, program, graphic creation, and alarming in user interface accessible by owner.

B. Operating System:
1. Concurrent, multi-tasking capability.
a. Common Software Applications Supported: Microsoft Excel.
2. System Graphics:
a. Verify all point naming for graphic mapping, alarming, and notification with owner.
b. Provide a software package to enable the operator to configure, modify, and delete system graphics.
c. System graphics shall appear on the operator workstation monitor complete with all associated data within five seconds of the completion of the operator entry/menu selection.
d. Real time data shall be superimposed on the system graphics and shall be updated at intervals between 10 and 20 seconds. The data shall be positioned on the display at points indicative of the instrumentation locations on the system.
e. Provide a library of commonly used symbols based on ASHRAE and ISA standards.
f. Graphics shall represent actual range of end device. Example: If VFC range is from 20% to 100%, graphical reference should match.
g. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
h. Animation displayed by shifting image files based on object status.
i. Provide method for operator with password to perform the following:
1) Move between, change size, and change location of graphic displays.
2) Modify on-line.
3) Add, delete, or change dynamic objects consisting of:
(a) Analog and binary values.
(b) Dynamic text.

(c) Static text.
(d) Animation files.

3. Custom Graphics Generation Package:
   a. Create, modify, and save graphic files and visio format graphics in PCX formats.
   b. HTML graphics to support web browser compatible formats.
   c. Capture or convert graphics from AutoCAD.
4. Standard HVAC Graphics Library:
   a. HVAC Equipment:
      1) Packaged Rooftop Units.
      2) Variable Air Volume Terminal Units.
      3) Unit Ventilators.
   b. Ancillary Equipment:
      1) Dampers.
      2) Ductwork.
5. Dynamic Color Graphic Displays:
   a. Up to Sixty (60) outputs of real time, live dynamic data per graphic.
   b. Dynamic graphic data.
   c. Modify graphic screen refresh rate between 1 and 60 seconds.
6. Provide system graphics for, at minimum, each of the following:
   a. Each floor of the building shall indicate the terminal unit zones. Separate the floor graphics into logical areas if the size of the floor is such that the presentation of data is not easily readable. Indicate the following for each zone:
      1) Red Background: Space temperature above alarm limit.
      2) Green Background: Space temperature within alarm limits.
      3) Blue Background: Space temperature below alarm limit.
      4) Space temperature superimposed on each zone area.
   b. Separate graphic for each terminal unit, which shall incorporate all operator changeable parameters and all input, output, and calculated values.
   c. A one-line graphic for all electrical systems indicating status of main equipment and monitored points.
7. The hierarchy of system graphics shall enable an operator to progress from a diagram of the building to a particular floor in the building and to a particular zone on the floor. The selection at each stage shall be by cursor control using a mouse or keyboard arrow buttons.
8. Provide target boxes on displays to enable easy access from one display to a related display. For example, provide a target box on the system diagram for a group of terminal units that will enable one-step access to the associated air handling unit.
9. Submit a complete set of the proposed system graphics in color at the shop drawing stage of the project.
10. Modify the system graphics as requested by the Owner and Consultant following shop drawing review at no additional cost to the Owner.
11. All large complicated graphics containing many data points shall be broken into more readable sections with easy access or arrows to each section.

C. Workstation System Applications:

1. Automatic System Database Save and Restore Functions:
    a. Current database copy of each Building Controller is automatically stored on hard disk.
    b. Automatic update occurs upon change in any system panel.
    c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
    a. Save database from any system panel.
    b. Clear a panel database.
    c. Initiate a download of a specified database to any system panel.
3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
4. On-line Help:
    a. Context-sensitive system assists operator in operation and editing.
    b. Available for all applications.
    c. Relevant screen data provided for particular screen display.
    d. Additional help available via hypertext.
5. Security:
    a. Operator log-on requires user name and password to view, edit, add, or delete data.
    b. System security selectable for each operator.
    c. System supervisor sets passwords and security levels for all other operators.
    d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
    e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
    f. All system security data stored in encrypted format.
6. System Diagnostics:
    a. Operations Automatically Monitored:
        1) Workstations.
        2) Printers.
        3) Modems.
        4) Network connections.
        5) Building management panels.
        6) Controllers.
    b. Device failure is annunciated to the operator.
7. Alarm Processing:
    a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
    b. Configurable Objects:
        1) Alarm limits.
        2) Alarm limit differentials.
        3) States.
        4) Reactions for each object.
8. Alarm Messages:
    a. Descriptor: English language.

b. Recognizable Features:
    1) Source.
    2) Location.
    3) Nature.

9. Configurable Alarm Reactions by Workstation and Time of Day:
    a. Logging.
    b. Printing.
    c. Starting programs.
    d. Displaying messages.
    e. Dialing out to remote locations.
    f. Paging.
    g. Providing audible annunciation.
    h. Displaying specific system graphics.
10. Custom Trend Logs:
    a. Definable for any data object in the system including interval, start time, and stop time.
    b. Trend Data:
        1) Sampled and stored on the building controller panel.
        2) Archivable on hard disk.
        3) Retrievable for use in reports, spreadsheets and standard database programs.
        4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
        5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
    a. View all system alarms and change of states from any system location.
    b. Events listed chronologically.
    c. Operator with proper security acknowledges and clears alarms.
    d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
    a. Provide a method to view, edit if applicable, the status of any object and property in the system.
    b. Status Available by the Following Methods:
        1) Menu.
        2) Graphics.
        3) Custom Programs.
13. Reports and Logs:
    a. Reporting Package:
        1) Allows operator to select, modify, or create reports.
        2) Definable as to data content, format, interval, and date.
        3) Archivable to hard disk.
    b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
    c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
    d. Set to be printed on operator command or specific time(s).
14. Reports:
    a. Standard:

1) Objects with current values.
2) Current alarms not locked out.
3) Disabled and overridden objects, points and SNVTs.
4) Objects in manual or automatic alarm lockout.
5) Objects in alarm lockout currently in alarm.
6) Logs:
(a) Alarm History.
(b) System messages.
(c) System events.
(d) Trends.

b. Custom:
1) Daily.
2) Weekly.
3) Monthly.
4) Annual.
5) Time and date stamped.
6) Title.
7) Facility name.

c. Tenant Override:
1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
2) Annual report showing override usage on a monthly basis.

d. Electrical, Fuel, and Weather:
1) Electrical Meter(s):
(a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
(b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
2) Fuel Meter(s):
(a) Monthly showing daily natural gas consumption for each meter.
(b) Annual summary showing monthly consumption for each meter.
3) Weather:
(a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

D. Workstation Applications Editors:
1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
a. Configuration.
b. Name.
c. Control parameters.
d. Set-points.
4. Scheduling:

a. Monthly calendar indicates schedules, holidays, and exceptions.
b. Allows several related objects to be scheduled and copied to other objects or dates.
c. Start and stop times adjustable from master schedule.

5. Custom Application Programming:
   a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
   b. Programming Features:
      1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
      2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
      3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
      4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
      5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
      6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
      7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
      8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values cab be used in IF/THEN comparisons, calculations, programming statement logic, etc.
      9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.8 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 ____ points, real or computed, with each point capable of collecting ____ 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. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match. Minimum capability shall include:
1. Add and delete points.
2. Modify any point parameter.
3. Change, add, or delete English language descriptors.
4. Add, modify, or delete alarm limits.
5. Add, modify, or delete points in start/stop programs, trend logs, etc.
6. Create custom relationship between points.
7. Create or modify DDC loops and parameters.
8. Create or modify override parameters.
9. Add, modify, and delete any applications program.
10. Add, delete, develop, or modify dynamic color graphic displays.

S. 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.

T. 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.

U. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.

V. 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.

W. 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.

X. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

Y. 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.

2.9 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, and 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 local UPS power supplies for all system panels and equipment.

E. Provide 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.

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

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. Rooftop unit with variable air volume terminal units.

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.
5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.
6. Include schedules, if known.

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. System and Equipment to BMCS Interfaces shall be provided for, but not limited to:
   1. Roof-Top Units.

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. 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.

C. Provide adequate English language notation in the software to assist the operator in understanding the intent of the programmed sequences.

D. 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.

E. 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.

F. Graphics shall represent actual range of outputs.

3.2 NIGHT (UNOCCUPIED) SETBACK - SETUP

A. Provide a software program that shall:
   1. Start HVAC equipment after normal hours of scheduled operation to maintain building after-hour setpoints, while reducing energy consumption.
   2. Night setback temperatures for heating shall be initially set at 55 degrees F to activate the heating equipment and 60 degrees F to stop the heating equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.
   3. Night setup temperatures for cooling shall be initially set at 90 degrees F to activate the cooling equipment and 85 degrees F to stop the cooling

equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.

B. The operator shall be able to implement this function for all HVAC equipment using an interactive procedure on an individual or group-controlled basis.

C. The operator shall be able to assign minimum run times for each piece of equipment.

D. The operation of this program shall be disabled when the outside air temperature is outside operator defined limits, initially set at 35 degrees F and 95 degrees F.

E. A report shall be available on demand and on a scheduled basis, which provides the following information:
   1. Night setback/setup setpoints and associated equipment.

F. This feature shall only be implemented for equipment in the BMCS software control mode.

G. Setpoints for each associated piece of equipment shall be displayed on the associated system display graphics. Setpoints shall be changeable via the graphical display.

H. The current status of night setback - setup modes shall be indicated on the associated system graphic.

3.3 OPTIMIZED SCHEDULING

A. Provide an adaptive software program that shall:
   1. Start HVAC equipment at the latest possible time while ensuring that space in the building reaches setpoint conditions by the time occupancy commences.
   2. Stop HVAC equipment at the earliest possible time while ensuring that space in the building shall still be within the setpoint deadband at the scheduled end of occupancy.

B. The operator shall be able to implement this function for each group of terminal units and other HVAC equipment using an interactive procedure. A group of terminal units shall comprise all the terminal units on the same floor of the tower served by the same air handling unit. The operator shall be able to assign start of occupancy and end of occupancy times for each day of the week and for holidays. A separate Monday schedule should be provided for earlier start times.

C. This program shall base the determined equipment start and stop times on monitored data such as space temperatures within the area served by the equipment and ambient conditions. If the BMCS subcontractor requires information other than that provided by the monitoring detailed in the Field Termination Schedules, then the necessary additional instrumentation shall be provided within the base bid price.

D. The operator shall be able to assign limits to the start and stop times. Initially these limits shall be set as follows:

1. BMCS determined start times shall not be more than three hours before the scheduled occupancy.
2. BMCS determined stop times shall not be more than one hour before the scheduled end of occupancy.

E. A report shall be available on demand and on a scheduled basis, which provides the following information:
1. Occupancy schedules.
2. Time of last equipment start and space conditions at scheduled occupancy time.
3. Time of last equipment stop and space conditions at scheduled end of occupancy time.

F. This feature shall only be implemented for equipment in the BMCS software control mode.

3.4 AIR TERMINAL UNITS

A. Single-Duct Variable Volume with Heat:
1. System Off - When the system is off:
a. The primary air damper shall be closed.
b. The heating shall be off.
2. Initiation of System Start-Up - The system shall be started:
a. Manually initiated by operator through BMCS.
b. Automatically by BMCS through occupancy schedule.
3. System Operation - After system start-up has been initiated the following shall occur:
a. The primary air damper shall modulate to the maximum primary airflow rate indicated to maintain the space cooling temperature setpoint.
b. When the space temperature falls below the space heating temperature setpoint the following shall occur:
1) The primary air damper shall be set to the minimum primary air flow rate indicated.
2) The heating electric coil controller shall modulate to maintain the space heating temperature setpoint.
3) The discharge air temperature sensor shall limit discharge air temperature to no more than 20 degrees above space setpoint.
4) Upon further call for heating, the primary air damper shall modulate to the maximum heating air flow rate indicated.
4. A2L Refrigerant Leak Detection Mode:
a. Shall be initiated as follows: Automatically by BMCS in response to feedback from the A2L refrigerant leak detector(s) which is/are factory-provided in the packaged rooftop air handler.
b. Upon refrigerant leak detection and as long as the A2L refrigerant leak detector(s) continues to detect refrigerant in the airstream, the electric heating coils of all variable volume terminal units shall be deenergized and the dampers of the terminal units shall be modulated to full open.
c. An alarm notification shall be sent to the specified facilities contact personnel indicating that the variable air volume terminal units are in refrigerant leak detection mode.

d. When the A2L refrigerant leak detector(s) no longer detect refrigerant, the variable air volume terminal units shall resume normal operation.
1) Note: The packaged rooftop air handler onboard controls also respond to feedback from the A2L refrigerant leak detector(s) and may have alarms/faults after a leak incident that will prohibit normal operation of the variable air volume terminal unit system until repair service has been initiated.

5. System Shutdown - Shall be initiated as follows:
a. Manually initiated by operator through BMCS.
b. Automatically by BMCS through occupancy schedule.

6. System Setpoints - The setpoints shall be operator changeable and initially set as follows:
a. Space cooling temperature setpoint shall be 74 degrees F.
b. Space heating temperature setpoint shall be 70 degrees F.
c. The minimum and maximum primary air flow setpoints shall be set to the design airflow setpoints as indicated in the contract documents.
d. The high and low temperature setpoints shall be set initially at 2 degrees F above/below the temperature setpoints.
e. The occupant shall have the capability to adjust the space temperature setpoint through the space temperature sensor.
f. The programming shall limit user adjustment to + or - 2 degrees F of the base setpoint.

7. Alarms - The BMCS shall generate an alarm for the following conditions:
a. High temperature.
b. Low temperature.

8. Points List:
a. Analog Inputs:
1) Primary air flow.
2) Space temperature.
3) Space temperature setpoint adjust.
4) Discharge air temperature.
b. Analog Outputs:
1) Primary air damper.
2) Heating electric coil controller.

3.5 ROOFTOP UNIT (VARIABLE VOLUME)

A. NOTE: The sequence of operation below is a generic representation of the proprietary sequence programmed in the manufacturer's onboard controller. It is not intended to override any operations of the the manufacturer's sequence. The building management control system (BMCS) will only interact with the manufacturer's sequence via the readable and writeable points available via the controller's software BACnet interface.

B. System Off - When the system is off:
1. The relief air dampers shall be closed.
2. The outside air dampers shall be closed.
3. The return air dampers shall be open.
4. Supply fan shall be off.
5. Power exhaust fan shall be off.

6. DX cooling shall be off.
7. Electric heating coils shall be off.

C. Initiation of System Start-Up - The system shall be started:
1. Manually initiated by operator through BMCS.
2. Automatically by BMCS through occupancy schedule.

D. System Operation - After system start-up has been initiated the following shall occur:
1. The supply fans shall be started at minimum speed. After a time period defined by the manufacturer's controls, the fans shall be enabled for automatic speed control.
2. The supply fan speed shall modulate according to the manufacturer's controls to maintain the supply static pressure setpoint. Pressure sensor shall be located 2/3 of the distance down the system ductwork.
3. The relief air damper and power exhaust fan shall modulate to maintain the building static pressure setpoint. The building pressure sensor shall compare the pressure difference between the inside and outside. Outside pressure shall be taken near the front door, low on the building, preferably south, or alternatively east or west sides of the building.
4. Economizer Control:
    a. Outside and return air dampers shall be modulated inversely proportionate to maintain a mixed air temperature set point approximately 2 deg. (adj.) less than the discharge air set point according to the manufacturer's controls.
    b. If local control is being used the economizer shall be enabled whenever:
        1) Outside air temperature is less than 65 deg (adj.)
        2) And outside air enthalpy is less than refernce enthalpy set point.
        3) Supply fan status is on.
    c. The economizer shall not be used whenever:
        1) Morning warm-up is enabled.
        2) If return air temperature is below 65 degrees (adj.) unless a “pre-cool” sequence is being used.
5. Minimum outside air damper shall modulate to the minimum outdoor air damper position setpoint, which is determined during the test-and-balance process.
6. The DX cooling shall modulate according to the manufacturer's controls to maintain a cooling supply air temperature set point.
7. The electric heat shall modulate according to the manufacturer's controls to maintain a heating supply air temperature set point.

E. A2L Refrigerant Leak Detection Mode:
1. Shall be initiated as follows: Automatically by BMCS in response to feedback from the A2L refrigerant leak detector(s) which is/are factory-provided in the packaged rooftop air handler.
2. Upon refrigerant leak detection and as long as the A2L refrigerant leak detector(s) continues to detect refrigerant in the airstream, the electric heating coil shall be deenergized, cooling shall be disabled, and the supply fan shall be modulated to full design speed, according to the manufacturer's controls. If required by the manufacturer's control sequence, the economizer and/or power exhaust may be enabled, as well.

3. When the A2L refrigerant leak detector(s) no longer detect refrigerant, the packaged rooftop unit shall resume normal operation unless prohibited by related faults/warnings, according to the manufacturer's controls.

F. System Shutdown - Shall be initiated as follows:
1. Manually initiated by operator through BMCS.
2. Automatically through occupancy schedule.
3. Automatically in the event of building power failure or fire alarm.

G. System Setpoints - The setpoints shall be operator changeable and initially set as follows:
1. Supply air temperature setpoint shall be 55 degrees F.
2. Space humidity setpoint shall be 50% RH.
3. Supply air pressure setpoint shall be 1.0 inches w.g.
4. Reference enthalpy setpoint shall be 28 Btu/lbda.
5. The minimum and maximum speed signal positions shall be set by the Balancing Contractor within the fan manufacturer's limitations.
6. The minimum outside air flowrate shall be as scheduled on the Mechanical Drawings.
7. The space pressure setpoint shall be 0.05 inches w.g.

H. Alarms - The BMCS shall generate an alarm for the following conditions:
1. Fan failure
2. General RTU failure
3. Heating/Cooling failure

I. Points List:
1. Software Interface - The following points shall be provided through the BACnet interface.
    a. Supply fan speed reference feedback.
    b. Supply fan fault.
    c. Power exhaust speed reference feedback.
    d. General unit alarm.
    e. Unit on/off status.
    f. Heating/cooling status.
    g. Cooling compressor capacity percentage.
    h. Electric heat capacity percentage.
    i. Supply air temperature setpoint.
    j. Supply air temperature.
    k. Supply air humidity.
    l. Supply air static pressure setpoint.
    m. Supply air static pressure.
    n. Space humidity setpoint.
    o. Reference enthalpy setpoint.
    p. Return air temperature.
    q. Return air humidity.
    r. Outside air temperature.
    s. Outside air humidity.
    t. Outside air damper position.

u. Outside air damper position setpoint for minimum outside air.
v. Return air damper position.
w. A2L refrigerant leak detector status.

END OF SECTION

SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal ducts.

B. Flexible ducts.

C. Nonmetal 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 x in./h x sq. ft. x deg F or W/m x 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. 29 CFR 1910.146 - Permit-Required Confined Spaces; Current Edition.

B. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2021.

G. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

I. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

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. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.

C. 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. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 33 19.

C. Duct Shape and Material in accordance with Allowed Static Pressure Range:
1. Round: Plus or minus 2 in-wc (500 Pa) of galvanized steel.
2. Rectangular: Plus or minus 1/2 in-wc (125 Pa) of galvanized steel.
3. Flat Oval: Plus 2 in-wc (500 Pa) of galvanized steel.

D. 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 (125 Pa) pressure class, galvanized steel.
   c. Return and Relief Air: 1 in-wc (250 Pa) pressure class, galvanized steel.

E. Duct Fabrication Requirements:
1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
2. 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.

3. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
4. Construct tees, 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 airfoil turning vanes of perforated metal with glass fiber insulation.
5. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
6. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
7. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
8. 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, 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. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.
   3. 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.
   4. 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.
   5. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
   6. Flange and Joint Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

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 recomendations for cable and locking mechanism sizes.
   3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

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.

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. MKT Metal Manufacturing: www.mktduct.com/#sle.
9. Nexus Inc.
10. Norlock
11. SEMCO Incorporated: www.semcoinc.com.
12. S.E.T. Duct Manufacturing
13. Sheet Metal Connectors.
14. United McGill Corp.: www.unitedmcgill.com.
15. Ward Industries, Inc.

B. Material Requirements:

1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.

C. Rectangular Metal Duct:
1. Rectangular Double Wall Insulated: Rectangular spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
a. Insulation:
1) Thickness: 1 inch (25 mm).
2) Material: Air.

D. Round Metal Ducts:
1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
2. Round Double Wall Insulated Duct: Round spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
a. Insulation:
1) Thickness: 1 inch (25 mm).
2) Material: Air.

E. Round Spiral Duct:
1. Round spiral lock seam duct with galvanized steel outer wall.

F. Connectors, Fittings, Sealants, and Miscellaneous:
1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
3. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
b. VOC Content: Not more than 250 g/L, excluding water.
c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
d. For Use with Flexible Ducts: UL labeled.
4. Gasket Tape:
a. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.

2.6 FLEXIBLE DUCTS

A. Flexible Air Ducts:
1. UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound spring steel wire.
2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
3. Pressure Rating: From 10 in-wc (2.5 kPa) positive to 1 in-wc (250 Pa) negative.

4. Maximum Velocity: 4,000 fpm (20.3 m/s).
5. Temperature Range: Minus 20 to 210 degrees F (Minus 28 to 99 degrees C).

B. Flexible Air Ducts:
1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
3. Pressure Rating: From 10 in-wc (2.5 kPa) to 1 in-wc (250 Pa) negative.
4. Maximum Velocity: 4,000 fpm (20.3 m/s).
5. Temperature Range: Minus 20 to 210 degrees F (Minus 28 to 99 degrees C).

C. Vapor Barrier Insulated Flexible Air Ducts:
1. UL 181, Class 1, two-ply polyester or vinyl film supported by helically wound spring steel wire.
2. Insulation: Fiberglass insulation with polyethylene vapor barrier core.
3. Pressure Rating: From 10 in-wc (2.5 kPa) positive to 1 in-wc (250 Pa) negative.
4. Maximum Velocity: 4,000 fpm (20.3 m/s).
5. Temperature Range: Minus 10 to 160 degrees F (Minus 23 to 71 degrees C).

2.7 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. 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:
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 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. 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.
9. 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 branch take-offs connecting to diffusers, registers and grilles, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
   1. Registers and diffusers with dampers shall be used only if devices are installed directly on the trunk duct.

G. Flexible Ducts: Connect to metal ducts with draw bands.
   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. Support flexible ductwork following manufacturer's recommendations and SMACNA HVAC Duct Construction Standards.
4. 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.
5. 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.

H. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.

I. 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.

J. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

K. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with a crimp in the direction of airflow.

L. Use double nuts and flat washer on threaded rod supports.

M. At exterior wall louvers, seal duct to louver frame.

N. Louver Fit-out:
1. Provide blank-out panels sealing available area of wall-mounted exterior-faced louver when connected ductwork is smaller than actual louver free area, and duct outlet is smaller than the louver frame.
2. Use the same duct material painted black on the exterior side, then seal louver frame and duct.

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.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air turning devices.

B. Duct access doors.

C. Duct test holes.

D. Volume control dampers.

E. Miscellaneous Products:
1. Internal strut end plugs.
2. Duct opening closure film.

F. Duct accessory hardware.

G. Filter gauges.

1.2 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

C. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

D. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.

B. Shop Drawings: Indicate for shop and field fabricated assemblies including volume control dampers and duct access doors.
1. Special fittings.
2. Motorized-control damper installations.
3. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer's Installation Instructions: Provide instructions for fire dampers, combination fire and smoke dampers, and smoke dampers.

D. Project Record Drawings: Record actual locations of access doors and test holes.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Extra Fusible Links: One of each type and size.

F. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

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

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Access Doors, Devices and Accessories:
1. Acudor Products Inc: www.acudor.com.
2. Carlisle HVAC Products: www.carlislehvac.com/sle.
3. Ductmate Industries, Inc.
4. Elgen Manufacturing: www.elgenmfg.com.
5. Flexmaster U.S.A., Inc.
6. Greenheck: www.greenheck.com
7. Krueger: www.krueger-hvac.com.
8. Lloyd Industries, Inc.: www.firedamper.com.
9. Nailor Industries Inc: www.nailor.com.
10. PCI Industries, Inc; Pottorff Brand [<>]: www.portorff.com.
11. Ruskin Company: www.ruskin.com.
12. SEMCO Incorporated: www.semcohvac.com.
13. Titus: www.titus-hvac.com.
14. United Enertech
15. Ventfabrics, Inc.
16. Vent Products Company, Inc.
17. Young Regulator Co
18. Ward Industries, Inc: www.wardind.com.

B. Dampers:
1. Air Balance, Inc.
2. Greenheck: www.greenheck.com
3. Louvers & Dampers, Inc: www.louvers-dampers.com.
4. Lloyd Industries, Inc.[<>]: www.firedamper.com.
5. Nailor Industries Inc[<>]: www.nailor.com.

6. NCA Manufacturing, Inc.: www.ncamfg.com
7. Pottorff/PCI Industries, Inc; Pottorff Brand : www.portorff.com.
8. Rossi: www.rossihardware.com
9. Ruskin Company: www.ruskin.com.
10. Tamco
11. United Enertech: www.unitedenertech.com/#sle.
12. Vent Products Company, Inc.
13. Ward Industries, Inc: www.wardind.com.

C. See paragraphs below for additional manufacturers.

2.2 SHEET METAL MATERIALS

A. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

B. Stainless Steel: ASTM A 480/A 480M.

C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 AIR TURNING DEVICES

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

2.4 DUCT ACCESS DOORS

A. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch (25 mm) thick insulation with sheet metal cover.
1. Less Than 12 inches (300 mm) Square: Secure with sash locks.
2. Up to 18 inches (450 mm) Square: Provide two hinges and two sash locks.
3. Up to 24 by 48 inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.
5. Access doors shall be provided with sash locks only when clearance space does not allow a door swing.

B. Access doors with sheet metal screw fasteners are not acceptable.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with foam insulation fill and 1-inch thickness.
   1. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Pressure Relief Access Door: Double wall and duct mounting; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.
   1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

2.5 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.

2.6 VOLUME CONTROL/BALANCING DAMPERS

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

B. Single Blade Dampers:
   1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
   2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.

C. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches (200 by 1825 mm). Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
   1. Blade: 18 gauge, 0.0478 inch (1.21 mm), minimum.

D. End Bearings: Except in round ducts 12 inches (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

E. Quadrants:
   1. Provide positive-locking, indicating quadrant regulators on single and multi-blade dampers.
   2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
   3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.

2.7 MISCELLANEOUS PRODUCTS

A. Internal Strut End Plugs: Combination end-mounting and sealing plugs for metal conduit used as internal reinforcement struts for metal ducts; plug crimped inside conduit with outside gasketed washer seal.

B. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
   1. Thickness: 2 mils (0.6 mm).
   2. High tack water based adhesive.
   3. UV stable light blue color.
   4. Elongation Before Break: 325 percent, minimum.

C. Jackshaft: 1-inch-diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.8 FILTER GAGES

A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   1. Diameter: 4-1/2 inches.
   2. Range: 0- to 0.5-inch wg.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Provide duct test holes where indicated and required for testing and balancing purposes.

D. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.

E. Provide volume control (balancing) dampers on duct take-off to all air inlets and outlets, diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

F. Provide volume control (balancing) dampers in all duct systems where indicated and required to perform complete system test and balance. Coordinate all volume damper locations with the test and balance contractor.

G. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

H. Provide turning vanes in all mitered duct turns.

I. Provide filter gage for each filter bank.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Section 23 0593 - Testing, Adjusting, and Balancing.

3.3 DEMONSTRATION

A. Demonstrate the following to the owner's representative and maintenance personnel:
1. Access to all volume damper position controls.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single-duct terminal units.
   1. Variable-volume units.

1.2 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).

C. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units; 2016.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

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

H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

I. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

B. 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 the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc (250 to 1000 Pa).

C. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.

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.

1.4 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 one year manufacturer warranty for fan powered air terminal units.

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 maintenace 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. Nailor Industries Inc.: www.nailor.com.

C. Price Industries.; www.priceindustries.com/

D. Titus; www.titus-hvac.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, reheat coil, access door and sound attenuating sections.
   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 to heating coils, dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Heating coil access doors located upstream of heating coil for coil cleaning purposes.

B. Basic Unit:
   1. Configuration: Air volume damper assembly inside unit casing.
   2. Locate control components inside protective metal enclosure.

2.5 SINGLE-DUCT, VARIABLE-VOLUME UNITS

A. Acoustic Performance Requirements:
   1. Sound ratings of air distribution assemblies: Not to exceed 30 NC at a .50" static pressure drop across the unit, and the downstream static pressure of .25".

B. General:
   1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, 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, coil type and coil (right or left hand) connection, where applicable.
   3. Basic Unit:
      a. Mount damper operator to position damper normally open.

C. Unit Casing:

1. Minimum 22 gauge, 0.0299 inch (0.76 mm) galvanized steel.
    a. Casing leakage to meet ASHRAE Std 130.
2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
3. Unit Discharge: Rectangular, with slip-and-drive connections.
4. Acceptable Liners:
    a. 3/4 inch (19 mm) thick adhesive of polyurethane or neoprene 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.
    b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

D. Damper Assembly:
1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak damper blades for tight airflow shutoff.

E. Electric Heating Coil:
1. Listed and provided by the terminal unit manufacturer.
2. Coil Casing: 20 gauge, 0.0359 inch (0.92 mm) galvanized steel.
3. Heating Elements: Nickel chrome, supported by ceramic insulators.
4. Integral Control Panel: NEMA, Type 1 enclosure with hinged access door for access to all controls and safety devices.
5. Furnish a primary automatic reset thermal cutout and differential pressure airflow switch for proof of airflow.
6. Provide the following additional components, mounted and/or wired within the control enclosure:
    a. Fused or non-fused door interlocking disconnect switch.
    b. Mercury contactors.
    c. Fuse block.
7. Provide SCR (Silicon Controlled Rectifier) controller.

F. Electrical Requirements:
1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.

G. Control Transformers: Factory supplied and mounted to power SCR heater controller and terminal unit controls.

H. Controls:
1. DDC (Direct-Digital Controls):
    a. See Section 23 09 23.
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.

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 control 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, electrical clearances, and access doors or panels with installation space available. Adjust indicated location of terminal unit if necessary to acheive required service clearances.

F. Locate units above easily removable ceiling components.

G. Support units individually from structure with wire rope complying with {\rs\#1} and 16 CFR 1201 in accordance with {rs#1}.

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. Provide minimum of 5 ft (1.5 m) of 1 inch (25 mm) thick lined ductwork downstream of units.

L. Verify that electric power is available and of the correct characteristics.

M. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

N. 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. Connect ductwork according to 23 3100 - HVAC Ducts and Casings. Prvide 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. 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. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
      b. Test and adjust controls and safeties.
      c. Replace damaged and malfunctioning controls and other equipment.
      d. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 23 74 13

PACKAGED OUTDOOR ROOFTOP UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Packaged outdoor rooftop units.

B. Roof mounting plenum curb.

1.2 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.

B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment; 2015, with Addendum (2016).

C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

1.3 SUBMITTALS

A. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

B. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

C. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

F. 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 set for each unit.

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.6 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of equipment that fail in materials or workmanship within specified warranty period. Warranty period for:
   1. Compressors and Refrigerant: Five (5) years.
   2. Heat Exchangers: Fifteen (15) years.
   3. Whole Unit Parts - Three (3) years.

B. Provide a five year warranty to include coverage for refrigeration compressors.

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. AAON: www.aaon.com.

B. Daikin Applied: wwwdaikinapplied.com.

C. Trane, a brand of Ingersoll Rand: www.trane.com.

D. Lennox: www.lennoxcommercial.com

E. Other, if approved in writing during the bid period by the Engineer and Owner.

F. Substitutions:

1. Voluntary Substitution: If a different manufacturer IN ADDITION TO the approved manufacturer represented by a given bidder is quoted, submit sufficient information to demonstrate to the Engineer and Owner that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substitute.

2.3 MANUFACTURED UNITS

A. General: Roof mounted units having electric heating elements or a heat exchanger and gas burner and electric refrigeration.

B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

C. Refrigerant: R-454B or R-32, listed to UL Standard 60335-2-40, with a factory-installed A2L refrigerant leak detection sysem.

D. Electrical Characteristics:
1. 480 VAC, three phase, 60 Hz.
2. 65kA Short Circuit Current Rating (SCCR)

E. Disconnect Switch: Factory mounted fused disconnect switch.

F. 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.

2.4 FABRICATION

A. Cabinet: Galvanized steel double-wall cabinet with a weather resistant baked enamel finish meeting 500+ hour ASTM B117 salt spray test, including hinged access panels with integrated quarter turn latches.. Structural members shall be minimum 18 gauge, 0.0478 inch (1.21 mm), with access panels of minimum 20 gauge, 0.0359 inch (0.91 mm).

B. Condensate Drain Pan: Stainless steel, double sloped.

C. Hoods: Outside air/economizer and relief, galvanized steel with a weather resistant baked enamel finish meeting 500+ hour ASTM B117 salt spray test.

D. Insulation: 1" minimum (R-7) injected foam insulation in double-wall panels.

2.5 SUPPLY FAN:

A. Direct drive type, resiliently mounted.

B. Motors: Variable speed, electronically commutated (EC) type.

C. Units with nominal capacities of 6 tons and larger shall be provided with plenum fans having backward-curved wheels.

D. Air Filters:
   1. Intake Filter Media: Aluminum mesh.
   2. Prefilter Media:
      a. 2-inch disposable pleated MERV 8
   3. After-Filter Media:
      a. 4-inch disposable pleated MERV 13
   4. Monitoring: Provide gauge with loaded setpoint-adjustable signal flag or external tag. Provide loaded filter alarm switch wired into unit controls with illuminated indicator on local control panel face.

2.6 ELECTRIC HEATING COIL

A. Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings easily accessible with automatic reset thermal cut-out, built-in magnetic contactors, galvanized steel frame, control circuit transformer and fuse, manual reset thermal cut-out, airflow proving device, toggle switch (pilot duty), load fuses.

B. Controls: Start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.

2.7 EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

B. Provide capillary tubes or thermostatic expansion valves for units of 6 Tons of refrigeration (21 kw) capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 Tons of refrigeration (26 kW) cooling capacity and larger.

2.8 COMPRESSOR

A. Provide direct-drive variable speed inverter digital scroll compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gage ports, and filter drier.

B. Provide capacity control by modulating compressors.

2.9 CONDENSER COIL

A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.

C. Provide refrigerant pressure switches to cycle condenser fans.

D. Provide condenser coil guards to protect from hail, wind, and other damage.

2.10 MIXED AIR CASING

A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Motorized outside air damper to fail to closed position. Relief dampers may be gravity balanced.

B. Gaskets: Provide tight fitting outdoor dampers with edge gaskets maximum leakage 5 percent at 2 inches (500 Pa) pressure differential.

C. Damper Operator: 24 volt with gear train sealed in oil.

2.11 ECONOMIZER

A. Provide a 0 to 100 percent reference enthalpy economizer with power exhaust.
   1. The economizer will compare the measured enthalpy of the outside air to a reference enthalpy setpoint to determine if it is cool enough and dry enough to allow the unit to go into economizing mode. Economizers that compare the measured enthalpy of the outside air to the measured enthalpy of the return air shall not be acceptable.

2.12 CONDENSER COIL COTTONWOOD HAIL GUARD/INTAKE FILTER SCREENING:

A. Engineered HVAC Mesh

B. Non-porous, UV resistant, vinyl coated polyester media w/non-stick surface.
   1. Flame resistant (self-extinguishing)
   2. Low debris adhesion
   3. Mold and mildew resistant.

C. 1.125” heavy duty fiber reinforced outer binding.
   1. Quick release nylon twist-lock fasteners.

D. Low air resistance and static pressure impact

E. 10 year Warranty

F. Basis of design: Air Solution Company, Heavy Duty Commercial Grade

2.13 POWER AND CONTROLS

A. Equipment and controls shall to interface and integrate to BMCS systems and sequences via vendor protocols including, as a minimum, BACnet, LonTalk and Modbus.

B. All remote sensors required by the factory-installed controller, including air temperature, space temperature, and humidity sensors, shall be furnished by the rooftop unit manufacturer. Unless otherwise noted, these sensors shall have a wired connection to the associated rooftop unit.

1. Space sensors shall be furnished without displays, setpoint adjustment buttons/sliders, and occupancy overrides.

C. Motor Control Panels: UL listed.

D. Include necessary motor starters, fuses, transformers and overload protection according to NFPA 70.

E. Provide single-point field connection to power supply.

F. Provide fused main disconnect integral to control panel.

G. Install wiring in accordance with NFPA 70.

H. Wiring: Enclosed in flexible, liquid tight steel conduit.

2.14 ROOF MOUNTING PLENUM CURB

A. Manufacturers:
1. Insulated Curbs: Thybar (www.thybar.com) or approved in writing equal.

B. Insulated Plenum Curb: G-90 Galvanized steel, reinforced sides, fully welded corners, base flange attachments for securing to building structure, factory installed wood nailer, gasketing, factory insulated at the exterior panels with minimum 3 inch thick, 3 pcf density rigid fiberglass insulation (R-12), with two plenums with floors and roofs to connect to supply and return air ductwork.
1. Basis of Design: Thybar TC-3
2. Plenums: Separate supply air and return air plenums shall be separated by a sheetmetal divider insulated with 1.5 inches of 3 pcf density rigid fiberglass insulation (R-6). The downflow packaged rooftop unit supply and return duct connections and existing supply and return ducts through the roof shall be connected to their respective plenums.
3. Walkable Plenum Roof/Cap: The plenum curb shall extend beyond the footprint of the packaged rooftop unit in order to connect to existing supply and return air ductwork through the roof. The portion of the curb not under the rooftop unit shall have a walkable roof/cap to allow maintenance personnel to stand on it to service the rooftop unit. The roof shall be insulated with minimum 3 inch thick, 3 pcf density rigid fiberglass insulation (R-12).
4. See the mechanical drawings for approximate curb dimensions and additional information.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.2 CONNECTIONS

A. Coordinate installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

B. Coordinate duct installation requirements with schematics on Drawings and with requirements specified for duct systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   1. Install ducts to termination in roof curb.
   2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
   3. The plenum curb to be installed in this project will be connected to existing supply and return ducts penetrating the roof. No new roof penetrations will be made.
   4. Provide flexible connection between ductwork and rooftop unit.

D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field quality-control tests and inspections and prepare test reports:
   1. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.4 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.5 DEMONSTRATION

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

3.6 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Provide filter gage on each filter bank. Refer to Section 23 3300.

3.7 SYSTEM STARTUP

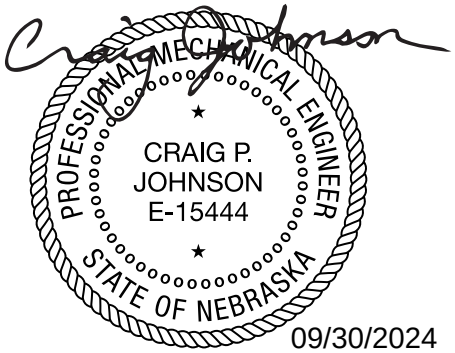
A. Prepare and start equipment. Adjust for proper operation.

B. Engage a factory-authorized service representative to perform startup service.

C. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Clean outside coil and inspect for construction debris.
   2. Adjust vibration isolators.
   3. Inspect operation of barometric dampers.
   4. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   5. Start unit according to manufacturer's written instructions.
      a. Start refrigeration system in summer only.
      b. Complete startup sheets and attach copy with Contractor's startup report.
   6. Inspect and record performance of interlocks and protective devices; verify sequences.
   7. Operate unit for an initial period as recommended or required by manufacturer.
   8. Calibrate thermostats.
   9. Adjust and inspect high-temperature limits.
   10. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
   11. Start refrigeration system and measure and record the following:
      a. Coil leaving-air, dry- and wet-bulb temperatures.
      b. Coil entering-air, dry- and wet-bulb temperatures.
      c. Outdoor-air, dry-bulb temperature.
      d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
   12. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

13. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through outside coil or from outside coil to outside-air intake.
14. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:
    a. High-limit heat exchanger.
    b. Warm-up for morning cycle.
    c. Freezestat operation.
    d. Economizer to limited outside-air changeover.
    e. Alarms.
15. After startup and performance testing, change filters, vacuum cooling and outside coils, and lubricate bearings.

END OF SECTION



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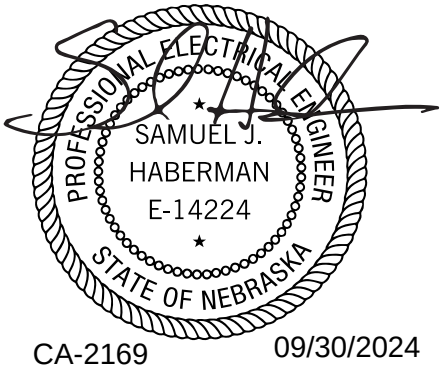


SECTION 26 04 00

COMMON REQUIREMENTS FOR ELECTRICAL

CA-2169 09/30/2024

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 warranty 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 ALTERNATES

A. Alternates, if required, shall be as described in the “Alternates” section of this Project Manual, as described on the proposal form, or as indicated on the drawings.

1.4 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.

1.5 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.

1.6 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.

1.7 SYMBOLS

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

1.8 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.

1.9 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.

1.10 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.

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 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.

1.12 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.

1.13 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 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.

1.14 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.

1.15 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.

1.16 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.

2.6 SLEEVES

A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.7 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.

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 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. Receptacle outlets (general): 18 inches.
   2. Receptacle outlets (kitchen, utility room, workbenches, etc.): 46 inches.
   3. Pushbuttons: 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 Engineer shall be sufficient cause for the rejection of any particular piece(s) of material, apparatus, equipment, etc., concerned.

3.8 SLEEVE INSTALLATION

A. Coordinate sleeve selection and application with selection and application of firestopping.

B. Concrete Slabs and Walls: Install sleeves during erection of slabs and walls. Space sleeves a minimum of three sleeve diameters on center, unless otherwise noted. Sleeves are not required for core-drilled penetrations.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Sleeves through walls: Install flush with both surfaces of wall.

E. Sleeves through floors: Extend 2 inches above finished floor.

F. Sleeves through roofs: Seal with flexible boot-type flashing units applied in coordination with roofing work

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceways or cable unless sleeve seal is to be installed.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

3.9 FIRESTOPPING

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

3.10 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.

3.11 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.

3.12 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.

3.13 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work. Repair as necessary.

3.14 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.

C. All cables and wiring shall be protected from paint. This includes but is not limited to power conductors and feeders, lighting control wiring, and fire alarm cabling. Painted cables shall be replaced in their entirety.

3.15 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.

E. Oxide inhibiting compound.

1.2 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).

E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2021).

F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation; 2018 (Reapproved 2023).

G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.

H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

I. NECA 104 - Standard for Installing Aluminum Building Wire and Cable; 2012.

J. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

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

L. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

N. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

O. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

P. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

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 except where aluminum conductors are specifically indicated. Substitution of aluminum conductors for copper is not permitted. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.
4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

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 Above a Roof: Type XHHW-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 (105 degrees C) for standard applications and 302 degrees F (150 degrees C) 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 (0.18

mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

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. Install aluminum conductors in accordance with NECA 104.

E. 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.

F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

G. Install conductors with a minimum of 6 inches (_____ mm) of slack at each outlet.

H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

J. 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 contaminates. Do not use wire brush on plated connector surfaces.
5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.

6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

K. 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.

L. Insulate ends of spare conductors using vinyl insulating electrical tape.

M. 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.

N. Identify conductors and cables in accordance with Section 26 05 53.

O. Install firestopping to preserve fire resistance rating of partitions and other elements.

P. 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

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; 2023.

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

C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

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 SUBMITTALS

A. Product Data: Provide for ground bars.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.6 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.

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, high-pressure compression conections, or high-pressure compression conections 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.

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

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; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

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

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 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 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, expansion anchors, 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 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 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. Galvanized steel rigid metal conduit (RMC).

B. Flexible metal conduit (FMC).

C. Liquidtight flexible metal conduit (LFMC).

D. Galvanized steel electrical metallic tubing (EMT).

E. Rigid polyvinyl chloride (PVC) conduit.

F. Accessories.

1.2 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2017.

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

G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

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

J. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

K. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

L. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.

M. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

N. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

O. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

P. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

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 DEFINITIONS

A. Telecommunications Pathway: Any item, raceway, box or enclosure in which telecommunications cabling is placed.

1.5 QUALITY ASSURANCE

1.6 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 Underground Installations:
1. Unless otherwise indicated, use rigid non-metallic conduit

C. Outdoor Locations Above Grade: Use rigid steel conduit.

D. Dry Locations:
1. Concealed: Use electrical metallic tubing.
2. Exposed: Use rigid steel conduit.

E. Connection to Motors: Use liquid-tight flexible metal conduit, except use flexible metal conduit in air plenums.

F. 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: 3/4-inch (21 mm) 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 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 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.

2.5 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.

2.6 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.
   2. Color Code:
      a. Fire Alarm: Red

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.

2.7 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.8 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

C. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 200 lbf (_____ kN).

D. Foam Conduit Sealant:
1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
3. Rated to hold minimum of 10 ft (3.0 m) water head pressure.

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. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.

D. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.

E. 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 (300 mm) between conduits and hot surfaces.
12. Group parallel conduits in same area on common rack.

F. 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.
    a. Support PVC conduit within 3 feet of termination points and at intervals not exceeding those listed below in accordance with NFPA 70 Table 352.30.
        1) 1/2" to 1" trade size = 3 feet spacing between supports.
        2) 1-1/4" to 2" trade size = 5 feet spacing between supports.
        3) 2-1/2" to 3" trade size = 6 feet spacing between supports.
        4) 3-1/2" to 5" trade size = 7 feet spacing between supports.
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.

G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
5. Provide insulated bushings on box connectors 1-inch and larger, on conduits stubbed above an accessible ceiling, and on conduits used for telecommunications pathways.
6. Secure joints and connections to provide mechanical strength and electrical continuity.

H. 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.

I. 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 change in length, calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground, is expected to be 1/4 inch or greater between securely mounted items such as boxes, cabinets, elbows, or other conduit terminations, which includes the following conditions:
   a. 100 foot intervals within spaces that have an ambient temperature range of 0-5 degrees Fahrenheit or less.
   b. 60 foot intervals within spaces that have an ambient temperature range of 5-10 degrees Fahrenheit or less.
   c. 40 foot intervals within spaces that have an ambient temperature range of 10-15 degrees Fahrenheit or less.
3. Where conduits are subject to earth movement by settlement or frost.

J. 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 condulet 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.

K. 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 (300 mm) at each end.

L. Provide grounding and bonding; see Section 26 05 26.

M. Identify conduits; see Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. 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 (1,650 cu cm), including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).

1.2 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

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

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).

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

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

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

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

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

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 (1,650 cu cm), 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. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
10. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
11. 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.
12. Wall Plates: Comply with Section 26 27 26.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
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 (1,650 cu cm):
    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. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

F. 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 (150 mm) 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 (610 mm) 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 (610 mm) 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.

G. 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.

H. Install boxes plumb and level.

I. 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 (6 mm) 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 (3 mm) at the edge of the box.

J. Install boxes as required to preserve insulation integrity.

K. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

L. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.

M. Close unused box openings.

N. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

O. Provide grounding and bonding in accordance with Section 26 05 26.

P. Identify boxes in accordance with Section 26 05 53.

Q. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

R. Orient each box located above an accessible ceiling so the box opening faces down or to one side.

S. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

T. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

U. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches (305 mm) 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; 2023.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.

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

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.
      b. Enclosed switches, circuit breakers, and motor controllers:
         1) Identify load(s) served.
   2. Available Fault Current Documentation: Use identification nameplate to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
      a. Service equipment.

B. 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 color-coded box covers to identify specified systems.
      a. Color-Coded Box Covers: Field-painted with two coats of enamel paint per the color code below:
         1) Fire Alarm System: Red.
      b. For exposed boxes in public areas, do not color code.
   2. 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 (1.6 mm); 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 (25 mm) by 2.5 inches (64 mm).
b. Identification Labels: 0.5 inch (12 mm) by 2.5 inches (64 mm).

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 (51 mm by 102 mm) 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 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

A. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. 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.

1.5 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 final power and control connections for equipment furnished under other Divisions of this specification and for Owner-furnished equipment. Where not specified in mechanical sections of this specification, connect motor controls and associated mechanical equipment as required for a complete and functional control system.

H. Provide interlocks and wiring to and between controls for Owner-furnished equipment, rooftop units, fan coil units, energy management system, product refrigeration, and terminal units..

I. 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.

B. Electric Duct Heaters:
   1. Provide step power and control conductors from control cabinet to duct heater where duct heater control cabinet is remote from the heater. Wire safety controls from heater to control cabinet.

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; 2023.

B. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

D. NEMA PB 1 - Panelboards; 2011.

E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

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

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

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

I. UL 67 - Panelboards; Current Edition, Including All Revisions.

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

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 (2,000 m).
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
      b. Panelboards Containing Fusible Switches: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

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.

J. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

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 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.
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 (2000 mm) 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. Receptacles.

B. Device plates and box covers.

1.2 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).

B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.

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

D. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

E. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

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 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 WIRING DEVICES - GENERAL REQUIREMENTS

A. Provide wiring devices suitable for intended use with ratings adequate for load served.

2.2 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.

2.3 WIRING DEVICE FINISHES

A. Device Color: Gray unless otherwise indicated or required by code; brown in dark brick, wood paneled or dark-finished walls.

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	TRBR20	BR20TR	T5362	TR5362

resistant				
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-A and USB-C charging ports	TRUSBAC20	USB20AC5	T5833	TR20USBAC6
Duplex TVSS	5362S	HBL5362SA	7380	5362SP
Clock hanger	775V	RR151CHI	688	S3713

2.5 WALL PLATES AND COVERS

A. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Screws: Metal with slotted heads finished to match wall plate finish.

B. Wall Plates for Flush Devices: Smooth plastic to match device color.

C. Weatherproof Receptacle 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.

2.6 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.

2.7 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.
   1. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
   2. Where multiple devices are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

C. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices unless otherwise indicated.

D. Install vertically mounted receptacles with grounding pole on bottom.

E. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas and above accessible ceilings.

2.8 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.

2.9 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

2.10 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; 2012.

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

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

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 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 avialable.

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; 2023.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

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

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

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

G. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

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 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 (2,000 m).
   2. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

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 (_____ mm) 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

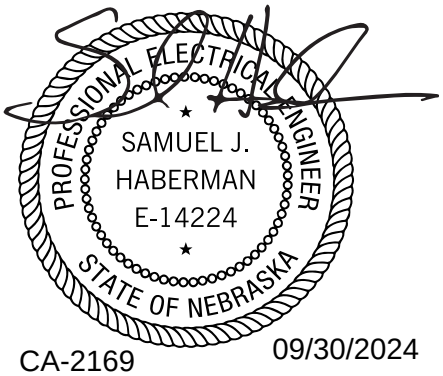
A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

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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