SWRWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT

JVWCD PROJECT No. 4287

OWNER

Jordan Valley Water Conservancy
District 8215 South 1300 West
West Jordan, Utah 84088
801-565-4300

ENGINEER

Heath Engineering
377 West 800 North
Salt Lake City, Utah 84103
(801)322-0487
heath@heatheng.com

November 2023

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NOTICE INVITING BIDS

PROJECT NAME: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

DESCRIPTION OF WORK: The scope of work described in these bid documents entails the retrofit of HVAC equipment to the SWGWTP and Education Center building.

SITE OF WORK: The work will be performed at the Education Center building and Southwest Groundwater Treatment Plant. Both facilities are at 8215 So. 1300 West, South Jordan, UT 84088.

OBTAINING CONTRACT DOCUMENTS: All Contract Documents may be obtained by electronic download from the District's Website jvwcd.org beginning November 20, 2023.

PRE-BID SITE VISIT: A non-mandatory pre-bid site visit will be held at the site of the work on November 30, 2023, at 3:00PM.

RECEIPT OF BIDS: Sealed bids will be received at the office of the Jordan Valley Water Conservancy District, Owner of the Work, located at 8215 South 1300 West, West Jordan, Utah 84088, until 3:00pm, December 14, 2023, for construction of the "SWGWTP and Education Center HVAC Improvements Project". Electronic bids may also be submitted in adobe .pdf format to ellisad@jvwcd.org. JVWCD requests that **electronic bids be submitted 15 minutes prior to the bid opening deadline.**

AWARD OF CONTRACT: An Award of Contract, if it were awarded, will be made within 60 calendar days of the opening of bids.

NOTICE TO PROCEED: A Notice to Proceed, if it were issued, will be made within 60 calendar days of the Notice of Award.

COMPLETION OF WORK: All work shall be completed within 180 calendar days from the date of the Notice to Proceed.

DISTRICT WEB SITE AND PLANHOLDERS LIST: Prospective bidders must register at the District's web site (www.jvwcd.org) under "Engineering Projects". Prospective bidders are required to check the District's web site for any addenda prior to submitting a responsive bid. The District's web site will be used to publish updated information relative to the project, including a planholders list.

COVID-19 WORK REQUIREMENTS: This work is expected to be completed under state COVID-19 work restrictions. Contractor is to require that all personal working on this project be healthy each workday and that those persons which might be ill are not allowed to work at District facilities. Contractor is to take other precautions as required by Salt Lake County Health officials.

NOTICE INVITING BIDS

BID SECURITY: Each bid shall be accompanied by a certified or cashier's check, money order or bid bond in the amount of five percent of the total bid price payable to the Jordan Valley Water Conservancy District as a guarantee that the bidder, if its bid is accepted, will promptly execute the contract, provide evidence of worker's compensation insurance, and furnish a satisfactory faithful performance bond in the amount of 100 percent of the total bid price and a payment bond in the amount of 100 percent of the total bid price.

ADDRESS AND MARKING OF BID: The envelope enclosing the bid shall be sealed and addressed to the Jordan Valley Water Conservancy District and delivered or mailed to 8215 South 1300 West, West Jordan, Utah 84088. The envelope shall be plainly marked in the upper left-hand corner with the name and address of the bidder and shall bear the words "Bid for," followed by the title of the Contract Documents for the work and the date and hour of opening of bids. The certified or cashier's check, money order, or bidder's bond shall be enclosed in the same envelope with the bid.

PROJECT ADMINISTRATION: All questions relative to this project prior to the opening of bids shall be directed to the Engineer for the project. It shall be understood, however, that no interpretations of the specifications will be made by telephone, nor will any "or equal" products be considered for approval prior to award of contract.

Engineer
Heath Engineering
377 West 800 North
Salt Lake City, Utah 84103
(801)322-0487
heath@heatheng.com
Project Manager:
Robert J. Kesler, PE
377 West 800 North
Salt Lake City, Utah 84103
801-597-3619
rkesler@heatheng.com

OWNER'S RIGHTS RESERVED: The Owner reserves the right to reject any or all bids, to waive any informality in a bid, and to make awards in the interest of the Owner.

Owner
Jordan Valley Water Conservancy District
Project Manager: Marcelo Anglade, PE
8215 South 1300 West
West Jordan, Utah 84088
Telephone: (801) 565-4300
marceloa@jvwcd.org
JORDAN VALLEY WATER CONSERVANCY DISTRICT

INSTRUCTIONS TO BIDDERS

FORM OF BID: The bid shall be made on the bidding schedule(s) bound herein. The bid shall be enclosed in a sealed envelope bearing the name of the bidder and name of the project. In the event there is more than one bidding schedule, the bidder may bid on any individual schedule or on any combination of schedules.

BID APPURTANCES: Bidders must provide bid appurtenances including Information required of bidder and experience reference projects. Bids not including the required information may be deemed non-responsive.

DELIVERY OF BID: The bid shall be delivered by the time and to the place stipulated in the Notice Inviting Bids. Alternately electronic bids will be accepted in adobe acrobat (.pdf) format. **Electronic bids must be sent to ellisad@jvwcd.org. It is the bidder's sole responsibility to see that the respective bid is received in proper time.**

WITHDRAWAL OF BIDS: Bids shall be unconditionally accepted without alteration or correction, except that bidder may by means of written request, signed by the bidder or his properly authorized representative withdraw his bid. Such written request must be delivered to the place stipulated in the Notice Inviting Bids for receipt of bids prior to the scheduled closing time for receipt of bids.

OPENING OF BIDS: The bids will be publicly opened and read at the time and place stipulated in the Notice Inviting Bids. According to state law, total bid amounts for each bidder will be posted to the District's website within 24 hours following receipt of the bids.

MODIFICATIONS AND ALTERNATIVE BIDS: Unauthorized conditions, limitations, or provisions attached to a bid may render it non-responsive and may cause its rejection. The completed bid forms shall be without interlineations, alterations, or erasures. Alternative bids will not be considered unless called for. Oral, telegraphic, or telephonic bids or modifications will not be considered.

DISCREPANCIES IN BIDS: In the event there is more than one bid item in a bidding schedule, the bidder shall furnish a price for all bid items in the schedule; failure to do so may render the bid non-responsive and subject to rejection. In the event there are unit price bid items in a bidding schedule and the "amount" indicated for a unit price bid item does not equal the product of the unit price and quantity, the unit price shall govern, and the "amount" will be corrected accordingly, and the Contractor shall be bound by said Correction. In the event there is more than one bid item in a bidding schedule and the total indicated for the schedule does not agree with the sum of the prices bid on the individual items, the prices bid on the individual items shall govern and the total for the schedule will be corrected accordingly, and the Contractor shall be bound by said correction.

INSTRUCTIONS TO BIDDERS

BID SECURITY: Each bid shall be accompanied by a certified or cashier's check or approved bid bond in the amount stated in the Notice Inviting Bids. Said check or bond shall be made payable to the Owner and shall be given as a guarantee that the bidder, if awarded the work, will enter into a contract within 10 calendar days after receipt of the contract from the Owner, and will furnish the necessary insurance certificates, Payment Bond, and Performance Bond; each of said bonds to be in the amount stated in the Notice Inviting Bids. In case the apparent low bidder refuses or fails to enter into such contract or fails to provide the required insurance and insurance certificates, the check or bid bond, as the case may be, shall be forfeited to the Owner. If the bidder elects to furnish a bid bond as his bid guarantee, he shall use the bid bond bound herein, or one conforming substantially to it in form.

BIDDER'S EXAMINATION OF CONTRACT DOCUMENTS AND SITE

It is the responsibility of each Bidder before submitting a Bid to:

1. Examine Contract Documents thoroughly.

2. Visit the site to become familiar with local conditions that may affect cost, progress, performance, or furnishing of the work.

3. Consider federal, state, and local laws and regulations that may affect cost, progress, and performance of furnishing of the work.

4. Study and carefully correlate the Bidder's observations with the Contract Documents.

5. Notify the Engineer of all conflicts, errors, or discrepancies in the Contract Documents.

Reference is made to the Supplemental General Conditions for identification of:

1. Those reports of exploration and tests of subsurface conditions at the site, which have been utilized by the Engineer in the preparation of the Contract Documents.

2. Those drawings of physical conditions in or relating to existing surface and subsurface conditions (except underground utilities as defined in Article 1 of the General Conditions) which are at or contiguous to the site and which were utilized by the Engineer in the preparation of the Contract Documents. Copies of such reports and drawings are available for inspection at the office of the Owner.

Information and data reflected in the Contract Documents with respect to underground facilities at/or contiguous to the site are based upon information and data furnished to the Owner and the Engineer by the owners of such underground facilities or others, and the Owner does not assume any responsibility for the accuracy or completeness thereof including any damages whatsoever that may be incurred by the Bidder or the Contractor through his reliance thereon unless it is expressly provided otherwise in the Supplemental General Conditions and/or the Technical Specifications.

Before submitting a bid, the bidder shall conduct such examination, investigations, studies and tests as are necessary to satisfy himself as to: the nature and location of the physical conditions (surface, subsurface and underground facilities), the general and local conditions particularly those bearing upon transportation, disposal, handling and storage of materials, availability of labor, availability of utilities, local weather conditions, the character of equipment and facilities required preliminary to and during the prosecution of the work; any and all other conditions that may in any way affect the cost, progress, performance or furnishing of materials in accordance with the Contract Documents. All such examinations, investigation, studies, tests and the like shall be at the Bidder's expense.

Upon reasonable request in advance, the Owner shall provide each Bidder with access to the site to conduct such explorations, examination, investigation, and tests as each Bidder may determine necessary for the submission of a Bid. The Bidder shall fill all holes, clean, and restore the site to its former condition upon the completion of such activities.

The submission of a bid hereunder shall be considered prima facie evidence that the Bidder has made such examination as is set forth in the above paragraph and is knowledgeable as to the location and site conditions surrounding the work and the conditions to be encountered in performing the work and as to the requirements, conditions and terms of the Contract and Contract Documents.

The Owner assumes no responsibility for any understanding or representations made by any of its officers or agents during or prior to the execution of this Contract, for information contained in any reports, subsurface studies, or other information which may be made available for the Contractor's information and which are not included as Contract Documents, for any understanding or representations by the Owner or by others which are not expressly stated in the Contract Documents which liability is not expressly assumed by the Owner or its representatives or Engineer in the Contract Documents. Such information shall be deemed to be for the information of the Contractor and the Contractor shall have the obligation of evaluating any such information as to its accuracy and effect the Owner will not be liable or responsible for any such information or any conclusions that may be drawn there from by the Contractor.

The lands upon which the work is to be performed, right-of-ways and easements for access thereto together with other lands designated for use by the Contractor in performing the work are identified in the Contract Documents. All additional lands and access thereto that are required for temporary construction facilities or storage of materials and equipment are to be provided by the Contractor. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by the Owner unless otherwise provided in the Contract Documents.

The submission of a Bid shall constitute an incontrovertible representation by the Bidder that the Bidder has complied with every requirement of this Article, and that without exception the Bid is premised upon performing and furnishing the work required by the Contract Documents in compliance with such means, methods, techniques, sequences, or procedures of construction as may be indicated in or required by the Contract Documents; and that such means, methods, techniques, sequences or procedures described in the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance and furnishing the work.

QUANTITIES OF WORK

The quantities of work or material stated in the Bid Schedule are supplied only to give an indication of the general scope of the work; the Owner does not expressly or by implication agree that the actual amount of work or material will correspond therewith. The Owner reserves the right after award of the Contract to increase or decrease the quantities of any unit price item of the work by an amount up to and including 25 percent of the quantity of any bid item, or to omit portions of such work as may be deemed necessary or expedient by the Engineer or Owner, without a change in the unit price. Such right to revise and omit shall include the right to delete any bid item in its entirety, or to add additional bid items in quantities up to and including an aggregate total amount not to exceed 25 percent of the total amount of the Contract.

The Bidders nor the ultimate Contractor on the Project shall at any time after the submittal of a bid make or have any claim for damages or anticipated profits or loss of profit or otherwise because of any difference between the quantities of work actually done and material furnished and those stated in said unit price items of the Bid.

INSTRUCTIONS TO BIDDERS

COMPETENCY OF BIDDERS: In selecting the lowest responsible Bidder, consideration will be given to the general competency of the Bidder for the performance of the work covered by the Bid. To this end, each bid shall be supported by a statement of the bidder's experience as of recent date on the form entitled "Information Required of Bidder," bound herein. No bid for the work will be accepted from a contractor who does not hold an active Contractor's license in good standing applicable to the type of work bid upon at the time of opening bids.

After an award of the contract no substitution of the Project Manager or Project Superintendent will be allowed without the written approval by the Owner.

DISQUALIFICATION OF BIDDERS: More than one bid from an individual, firm partnership, corporation, or association under the same or different names will not be considered. Reasonable grounds for believing that any bidder is interested in more than one bid for the work contemplated will cause the rejection of all bids in which such bidder is interested. If there is reason for believing that collusion exists among the bidders, all bids will be rejected.

RETURN OF BID GUARANTEE: Within 10 calendar days after awarding the contract, the Owner will return the bid guarantees accompanying such of the bids as are not considered in making the award. All other bid guarantees will be held until a Notice to Proceed has been issued and accepted. They will then be returned to the respective bidders whose bids they accompany.

AWARD OF CONTRACT: Award of the Contract, if it be awarded, will be based primarily on the lowest overall cost to the Owner, and will be made to a responsive and responsible bidder whose bid complies with all the requirements prescribed. Any such award will be made by written notice and within 60 calendar days after opening of the bids, unless a different waiting period is expressly allowed in the Notice Inviting Bids. Unless otherwise indicated, an award will not be made for less than all the bid items in an individual bidding schedule. In the event the entire work is contained in more than one bidding schedule, the Owner may award schedules individually or in combination. In the case of two bidding schedules which are alternate to each other, only one of such alternate schedules will be awarded.

INSTRUCTIONS TO BIDDERS

EXECUTION OF CONTRACT: The Bidder to whom the award is made shall secure all insurance and shall furnish all certificates and bonds required by the specifications within ten calendar days after receipt of the Notice of Award from the Owner. The Bidder to whom the award is made shall execute a written contract with the Owner on the form of agreement provided within ten calendar days after receipt of the Agreement from the Owner. Failure or refusal to enter into a contract as herein provided or to conform to any of the stipulated requirements in connection therewith shall be just cause for annulment of the award and forfeiture of the bid guarantee. If the successful bidder refuses or fails to execute the contract, the Owner may award the contract to the second lowest responsible bidder or reject all bids and re-advertise the project for rebidding. If the second lowest responsible bidder refuses or fails to execute the contract, the Owner may award the contract to the third lowest responsible bidder. On the failure or refusal of such second or third lowest bidder to execute the contract, each such bidder's guarantees shall be likewise forfeited to the Owner.

ISSUANCE OF NOTICE TO PROCEED: The Owner intends to execute the Agreement and issue the Notice to Proceed specifying the Project start date within ten calendar days after its receipt of the executed Agreement, Purchase Order Assignment(s), (if applicable), bonds and insurance certificates from the successful bidder. If the Contract Time is expressed as a specific completion date in the Notice Inviting Bids and paragraph 3.1 of the Agreement rather than a specific number of successive days following the start date identified in the Notice to Proceed, then any delay by the Owner beyond the ten days in issuing the Notice to Proceed shall extend the completion date by the number of days of the delay.

LICENSES: Contractor must be licensed as a business qualified to do business within the state of Utah prior to issuance of a Notice of Award. Contractor must hold a current contractor’s license with classifications appropriate to the work being contracted.

BID

BID TO: JORDAN VALLEY WATER CONSERVANCY DISTRICT

The undersigned Bidder hereby proposes to furnish all plant machinery, labor, services, materials, equipment, tools, supplies, transportation, utilities, and all other items and facilities necessary to perform all work required under the Bidding Schedule of the Owner's Contract Documents entitled "SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT" drawings and all addenda issued by said Owner prior to opening of the bids.

Addenda are only delivered by e-mail and through the internet.

The undersigned bidder acknowledges receipt of the following addenda:

No.	Date Received	No.	Date Received

Bidder agrees that, within 10 calendar days after receipt of Notice of Award from Owner, he will execute the Agreement in the required form, of which the Notice Inviting Bids, Instructions to Bidders, Bid, Information Required of Bidder, Technical Specifications, Drawings, and all addenda issued by Owner prior to the opening of bids, are a part, and will secure the required insurance and bonds and furnish the required insurance certificates; and that upon failure to do so within said time, then the bid guarantee furnished by Bidder shall be forfeited to Owner as liquidated damages for such failure; provided, that if Bidder shall execute the Agreement, secure the required insurance and bonds, and furnish the required insurance certificates within said time, his check, if furnished, shall be returned to him within five days thereafter, and the bid bond, if furnished, shall become void. It is further understood that this bid may not be withdrawn for a period of 45 days after the date set for the opening thereof, unless otherwise required by law.

Dated: _____ Bidder: _____

By: _____
(Signature)

Title: _____

Bidder further agrees to complete all work required within the time stipulated in the Contract Documents, and to accept in full payment therefore the price(s) named in the above-mentioned Bidding Schedule(s).

BID BOND

BID SCHEDULE(S)

Name of Project: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT

JVWCD Project No: 4287

Contractor: _____

The bid amount shall include cost utilization with the following breakdown of costs.

SWGWTP BUILDING

Initial Mobilization:	$ _____
Mechanical Equipment:	$ _____
Mechanical Installation Labor:	$ _____
Controls Equipment:	$ _____
Controls Installation and Programming:	$ _____
Electrical Equipment:	$ _____
Electrical Installation Labor:	$ _____
Substantial Completion and De-Mobilization:	$ _____
SWGWTP Building Bid Amount:	$ _____

BID BOND

BID SCHEDULE(S)

Name of Project: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS ROJECT

JVWCD Project No: 4287

Contractor: _____

The bid amount shall include cost utilization with the following breakdown of costs.

EDUCATION CENTER BUILDING

Initial Mobilization:	$ _____
Mechanical Equipment:	$ _____
Mechanical Installation Labor:	$ _____
Controls Equipment:	$ _____
Controls Installation and Programming:	$ _____
Electrical Equipment:	$ _____
Electrical Installation Labor:	$ _____
Substantial Completion and De-Mobilization:	$ _____
EDUCATION CENTER Building Bid Amount:	$ _____

BID BOND

BID SCHEDULE(S)

Name of Project: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT

JVWCD Project No: 4287

Contractor: _____

TOTAL PROJECT BID SUMMARY

SWGWTP BUILDING

Bid Amount: $ _____

EDUCATION CENTER BUILDING

Bid Amount: $ _____

TOTAL BID AMOUNT: $ _____

Signed: _____

BID BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____
as Principal, and _____
as Surety, are held and firmly bound unto the Jordan Valley Water Conservancy District (hereinafter called "Owner") in the sum of _____ dollars, (not less than five percent of the total amount of the bid) for the payment of which sum, will and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, Principal has submitted a bid to Owner to perform all work required under the bidding Schedule of the Owner's Contract Documents entitled "SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT", (hereafter called the "Project").

NOW THEREFORE, if Principal is awarded Contract by Owner for the Construction of the Project and, within the time and in the manner required under the heading "Instructions to Bidders" enters into the written contract entitled "Agreement" bound with said Contract Documents, furnishes the required certificates of insurance, and furnishes the required Performance Bond and Payment Bond within 10 calendar days after receipt of such contract from Owner, then this obligation shall be null and void, otherwise it shall remain in full force and effect. In the event suit is brought upon this bond by Owner and judgment is recovered, Surety shall pay all costs incurred by Owner in such suit, including a reasonable attorney's fee to be fixed by the court.

SIGNED AND SEALED, this _____ day of _____, 20___.

_____ _____

By: _____ By: _____

Its: _____ Its: _____

(SEAL) (SEAL)

INFORMATION REQUIRED OF BIDDER

The Bidder shall furnish the following information. Failure to comply with this requirement may render the Bid non-responsive and subject to rejection. Additional sheets shall be attached as required.

1. Contractor firm information:

Contractor's name: _____

Contractor's address: _____

_____

_____

Contractor's Primary Contact: _____

Email address of Contractor's primary contact: _____

Contractor's telephone number: _____

2. Contractor must be qualified and licensed to do business in Utah.

Utah Department of Commerce Information

Business Entity Number: _____

Delinquent Date: _____

3. Contractor must hold a current contractor's license, classification E100.

Contractor's Utah License Number: _____

Expiration Date: _____

Primary Classification: _____

Supplemental Classification held, if any: _____

INFORMATION REQUIRED OF BIDDER

5. **Key Personnel Qualifications and Experience**

List key personnel here and provide detailed information in Attachments A and B. More than one Project Manager and/or Project Superintendent may be proposed. Only personnel approved by the Owner will be allowed in the key positions.

Project Manager A: _____

Project Manager shall have:

- At least five (5) years' experience
- Have successfully performed as Project Manager on the construction of at least three (3)

Project Superintendent A: _____

Project Superintendent shall have:

- At least ten (10) years' experience
- Have successfully performed as Superintendent on the construction of at least five (5) pressure

6. **Previous Contractor Project Experience**

Past project experience shall be provided for each requirement. The Owner shall be entitled to contact each, and every reference listed by the contractor. The Contractor, by submitting a prequalification proposal, expressly agrees that any information concerning the CONTRACTORS in possession of said entities and references may be made available to the owner.

Provide the information identified in Attachment C for each project listed below

Requirements:

Contractor shall have successfully completed at least three (3) boiler replacement projects within the last ten (10) years of similar size and complexity.

INFORMATION REQUIRED OF BIDDER

1. _____

2. _____

3. _____

4. _____

List at least one (1) project successfully with a total value of at least $350,000.

1. _____

INFORMATION REQUIRED OF BIDDER

Electrical Subcontractor Experience

1. _____

2. _____

3. _____

7. Number of years as a contractor in construction work of this type:

_____

8. Name and title of officers of Contractor's firm:

_____

_____

_____

9. Number of persons employed full-time by the firm: _____

10. Name of person who inspected site of proposed work for your firm:

Name: _____

Date of Inspection: _____

11. Surety company who will provide the required bonds on this contract: _____ __

Agent's Name:_____

Telephone:_____

12. Workers Compensation Insurance Policy #: _____

INFORMATION REQUIRED OF BIDDER

ATTACHMENT A
(Copy as necessary – recommended to provide more projects than required)

Project Manager Data Sheet

Name: _____

Years experienced as Project Manager: _____

Years of prior experience: _____ Positions: _____

Qualifying Project #1: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #2: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #3: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

INFORMATION REQUIRED OF BIDDER

ATTACHMENT B

Superintendent Data Sheet

Name: _____

Years experienced as Superintendent: _____

Years of prior experience: _____ Positions: _____

Qualifying Project #1: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #2: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #3: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

INFORMATION REQUIRED OF BIDDER

ATTACHMENT C

Contractor Project Experience Summary

Qualifying Project #1: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #2: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #3: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

INFORMATION REQUIRED OF BIDDER

ATTACHMENT D

Electrical Sub-Contractor Project Experience Summary

Qualifying Project #1: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #2: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

Qualifying Project #3: _____

Project Summary: _____

Year Completed: _____

Total Cost: _____

Owner: _____

Owner Contact Person: _____ Telephone: _____

AGREEMENT

An Agreement made as of the _____ day of _____, 20___, by and between the Jordan Valley Water Conservancy District, a Utah special district ("OWNER"), and _____, a _____ corporation qualified to do business and doing business in the State of Utah ("CONTRACTOR").

TERMS:

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE I
WORK

CONTRACTOR shall complete all Work as specified or indicated in the Contract Documents for the _____. The Work is generally described as follows:

> Furnishing all labor, services, materials, equipment, and supplies except for such materials, equipment, and services as may be stipulated in the Contract Documents to be furnished by the OWNER; furnishing and removing all plant machinery, temporary structures, tools, supplies, transportation, utilities, and all other items, facilities and equipment, and to do everything required by this Agreement and the Contract Documents; accepting all responsibility for and paying for all loss and damage arising out of the nature of the Work aforesaid, or from the action of the elements, or from any unforeseen difficulties which may arise during the prosecution of the Work until its acceptance by OWNER, and for all risks of every description connected with the Work; also for all expenses resulting from the suspension or discontinuance of work, except as in the Contract Documents are expressly stipulated to be borne by OWNER.

ARTICLE II
ENGINEER

The Project has been designed by the OWNER. The OWNER will assume all duties and responsibilities and have the rights and authority assigned to ENGINEER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

[ALTERNATE PARAGRAPH]The Project has been designed by _____, a _____ corporation qualified to do business and doing business in the State of Utah, who is hereinafter called "ENGINEER" and who is to act as OWNER's representative, assume all duties and responsibilities and have the rights and

authority assigned to ENGINEER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE III
CONTRACT TIME

3.1 The Work shall be complete, in accordance with paragraphs 14.08 and 14.09 of the General Conditions, on or before _____.

3.2 Liquidated Damages: OWNER and CONTRACTOR recognize that time is of the essence of this Agreement and that the OWNER will suffer financial loss if the Work is not completed within the time specified in paragraph 3.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by OWNER if the Work is not completed on time. Accordingly, instead of requiring any proof of loss, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) CONTRACTOR shall pay OWNER the amount specified in Article 14.07 of the General Conditions and in Article 18.01 of the Supplementary General Conditions for each day that expires after the time specified in paragraph 3.1 for final completion until the Work is substantially complete. And, after Substantial Completion if CONTRACTOR neglects, refuses or fails to complete the remaining Work within forty-five (45) days or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER the amount specified in Article 14.07 of the General Conditions and in Article 18.01 of the Supplemental General Conditions for each day that expires after the forty-five (45) days until readiness for final payment.

ARTICLE IV
CONTRACT PRICE

All payments to Contractor shall be made in accordance with the Contract Documents. OWNER shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents in current funds those prices stated in the approved Bid Schedule as named in the Notice of Award.

ARTICLE V
PAYMENT PROCEDURES

CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

5.1 Progress Payments: OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR's Applications for Payment

as recommended by ENGINEER, on a monthly basis. All progress payments will be on the basis of the progress of the Work measured by the schedule of values established in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Conditions.

5.2 Final Payment: Upon final completion and acceptance of the Work in accordance with Article 14 of the General Conditions, OWNER shall pay the remainder of the Contract Price as recommended by ENGINEER as provided in Article 14.

ARTICLE VI
INTEREST

All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the rate of twelve percent (12%) per annum.

ARTICLE VII
CONTRACTOR'S REPRESENTATION

In order to induce OWNER to enter into the Agreement, CONTRACTOR makes the following representations:

7.1 CONTRACTOR has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

7.2 CONTRACTOR has studied carefully all exploration reports and test of subsurface conditions and drawings of physical conditions which are identified in the Supplementary General Conditions, as provided in paragraph 4.02 of the General Conditions, and accepts the Technical Data contained in such reports and drawings upon which CONTRACTOR is entitled to rely.

7.3 CONTRACTOR has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests, reports and studies (in addition to or to supplement those referred to in paragraph 7.2 above) which pertain to the subsurface or physical conditions at or contiguous to the site or otherwise may affect the cost, progress, performance or furnishing of the Work as CONTRACTOR considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of paragraph 4.02 of the General Conditions; and no additional examinations, investigations, explorations, tests, reports,

studies or similar information or data are or will be required by CONTRACTOR for such purposes.

7.4 CONTRACTOR has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities.

7.5 CONTRACTOR has correlated the results of all observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Contract Documents.

7.6 CONTRACTOR has given ENGINEER written notice of all conflicts, errors or discrepancies that he had discovered in the Contract Documents and the written resolution thereof by ENGINEER is acceptable to CONTRACTOR.

ARTICLE VIII
CONTRACT DOCUMENTS

The Contract Documents for the _____, which comprise the entire agreement between OWNER and CONTRACTOR concerning the Work, consist of the following:

8.1 This Agreement;
8.2 Performance and Payment Bonds;
8.3 Notice of Award;
8.4 Notice to Proceed;
8.5 General Conditions;
8.6 Supplemental General Conditions;
8.7 Notice Inviting Bids;
8.8 Instructions to Bidders;
8.9 Information Required of Bidder;
8.10 Technical Specifications;
8.11 Drawings - Sheets Number One through _____;
8.12 Addendum Number One through _____; and,
8.13 CONTRACTOR's Bid, including all schedules and explanatory attachments; attached as Exhibit A.

The CONTRACTOR (1) acknowledges that he has received a copy of each document, specified above, (2) acknowledges that he has read and understands each document specified above and (3) agrees to every term, condition and contract obligation set forth in each document specified above.

There are no Contract Documents other than those listed above in this Article 8. The Contract Documents may only be amended, modified or supplemented as provided in paragraphs 3.03 of the General Conditions.

ARTICLE IX
FEDERAL REQUIREMENTS

The CONTRACTOR shall comply with federal regulations as stated in the Supplemental General Conditions, Article 21.

ARTICLE X
MISCELLANEOUS

10.1 Terms used in this Agreement which are defined in Article 1 of the General Conditions will have the meanings indicated in the General Conditions.

10.2 No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.3 In the event any legal action or other proceeding is brought for the enforcement of this Agreement and/or the Contract Documents, or for damages, because of an alleged dispute, breach, default or misrepresentation in connection with any of the provisions thereof, the successful or prevailing party shall be entitled to recover reasonable attorneys' fees and other costs incurred in the action or proceeding, in addition to any other relief to which it may be entitled.

10.4 Any notice to be given hereunder shall be deemed given when sent by registered or certified mail, postage prepaid to the parties at their respective addresses stated below or at any other address when notice of such change of address has been given as provided in this Article 10.4.

[SIGNATURE PAGE FOLLOWS]

"OWNER":	"CONTRACTOR":
Jordan Valley Water Conservancy District 8215 South 1300 West West Jordan, Utah 84088	_____ _____ _____ Utah License No. _____
By: _____ Alan E. Packard Its General Manager/CEO	By: _____ Its: _____

EXHIBIT A

CONTRACTOR'S BID

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____, as Contractor, and _____ as Surety, are held firmly bound unto the Jordan Valley Water Conservancy District hereinafter called "Owner," in the sum of $_____ for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, Contractor has been awarded and is about to enter into the annexed Agreement with Owner to perform all work required under the Bidding Schedule(s) of the Owner's Contract Documents entitled SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

NOW THEREFORE, if Contractor shall perform all the requirements of the Agreement required to be performed on his part, at the times and in the manner specified therein, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

PROVIDED, that any alterations in the work to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of the Agreement, shall not in any way release Contractor or Surety thereunder, nor shall any extensions of the time granted under the provisions of the Agreement release either the Contractor or Surety, and notice of such alterations or extensions of the work, materials or time to complete made under the Agreement is hereby waived by Surety. This Bond is furnished in compliance and in accordance with 14-1-18, Utah Code Ann., as amended, and 63-56-38 Utah Code Ann., as amended.

SIGNED AND SEALED, this _____ day of _____, 20__.

_____ _____

By: _____ By: _____

Its: _____ Its: _____

(SEAL) (SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGMENT OF SURETY)

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____ as Contractor, and _____ as Surety, are held firmly bound unto the Jordan Valley Water Conservancy District hereinafter called "Owner," in the sum of $_____ for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, Contractor has been awarded and is about to enter into the annexed Agreement with Owner to perform all work required under the Bidding Schedule(s) of the Owner's Contract Documents entitled, SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

NOW THEREFORE, if said Contractor, or subcontractor, fails to pay for any materials, equipment, or other supplies, or for rental of same, used in connection with the performance of work contracted to be done, or for amounts due under applicable State law for any work or labor thereon, said Surety will pay for the same in an amount not exceeding the sum specified above, and, in the event suit is brought upon this bond, a reasonable attorney's fee to be fixed by the court. This bond shall inure to the benefit of any persons, companies, or corporations entitled to file claims under applicable State law.

PROVIDED, that any alterations in the work to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of the Agreement, shall not in any way release Contractor or Surety thereunder, nor shall any extensions of time granted under the provisions of said contract release either Contractor or the Surety, and notice of such alterations or extensions of the work, materials or time to complete made under the Agreement is hereby waived by Surety. This bond is furnished in compliance and in accordance with 14-1-18 and 19 Utah Code Ann., as amended, and 63-56-38 Utah Code Ann., as amended.

SIGNED AND SEALED, this _____ day of _____, 20___.

_____ _____

By: _____ By: _____

Its: _____ Its: _____

(SEAL) (SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGMENT OF SURETY)

NOTICE OF AWARD

To:

Re: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

You are hereby notified that the OWNER has accepted your bid for the above referenced project in the amount of $_____.

Furnish the required Contractor's Performance Bond, Payment Bond and Certificates of Insurance within ten calendar days from the date of this notice to you. An acknowledged copy of this Notice of Award, together with all future correspondence regarding this project, shall be sent to the District's Project Manager: Marcelo Anglade, PE.

When the Agreement is provided, sign and return it within ten calendar days from receipt of the agreement.

Dated this ____ day of _____, 20___.

_____
Shane Swensen, PE
Engineering Department Manager & Chief Engineer

ACCEPTANCE OF NOTICE

Receipt of the above Notice of Award is hereby acknowledged by:

_____

This _____ day of _____, 20___.

Signature:_____

Printed Name:_____

Title: _____

NOTICE TO PROCEED

To:

Re: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT

You are hereby notified to commence work in accordance with the Agreement dated _____, on or before _____, and you are to complete the work by, _____.

An acknowledged copy of this Notice to Proceed should be returned to the Owner, Attention: Marcelo Anglade

Dated this _____ day of _____.

_____
Shane K Swensen, P.E.
Engineering Department Manager

ACCEPTANCE OF NOTICE

Receipt of the above Notice to Proceed is hereby acknowledged by:

_____

This _____ day of _____, 20___.

Signature:_____

Printed Name:_____

Title: _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

PAYMENT APPLICATION AND CERTIFICATE No. ___ DATE: _____

SHEET _____ OF _____

PERIOD FROM _____ TO _____, 20___

PROJECT: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

JVWCD PROJECT NO.: __4287_____

CONTRACTOR: _____

ADDRESS: _____

ENGINEER: _____

1. ORIGINAL CONTRACT PRICE:..... $_____

2. NET CHANGE ORDERS APPROVED TO DATE: ..... $_____
(Attach Summary Sheet)

3. REVISED CONTRACT AMOUNT: ..... $_____
(Sum of Lines 1 & 2)

4. TOTAL VALUE OF WORK COMPLETED TO DATE ... . $_____
(Attached Payment Breakdown)

5. PERCENT PROJECT COMPLETE: ..... _____%
(Divide Line 4 by 3 and multiply by 100)

6. LESS AMOUNT RETAINED (5%) ..... $_____

7. MATERIALS ON HAND..... $_____
(95% of Value, Listing Attached)

8. SUBTOTAL (Sum of Lines 4, Line 6 and Line 7)..... $_____

9. LESS PREVIOUS PAYMENTS ..... $_____

10. CURRENT PAYMENT DUE: ..... $_____
(Line 8 & 9)

JORDAN VALLEY WATER CONSERVANCY DISTRICT

Payment Application and Certificate No _____

SHEET _____ OF _____

CONTRACTOR'S Certification:

The undersigned CONTRACTOR certifies that: (1) all previous progress payments received from OWNER on account of work done under the Contract referred to herein have been applied to discharge in full all obligations of CONTRACTOR incurred in connection with work covered by prior Applications for Payment numbered 1 through _____ inclusive; and, (2) title to all materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to OWNER at time of payment free and clear of all liens, claims, security interests and encumbrances (except such as covered by bond acceptable to OWNER).

Dated: _____ CONTRACTOR: _____

By: _____

Engineer's Recommendation:

This Application (with accompanying documentation) meets the requirements of the Contract Documents and payment of the amount due this application is recommended.

ENGINEER

Dated _____ _____

Project Representative

Dated _____ _____

Project Manager

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CHANGE ORDER

Change Order No. _____

Date: _____

Page ___ of ___

NAME OF PROJECT: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

PROJECT NUMBER: ___4287_____

CONTRACTOR: _____

CONTRACT DATE: _____

The following changes are hereby made to the CONTRACT DOCUMENTS:

1)

2)

3)

Total Change to CONTRACT PRICE: ..... $

Original CONTRACT PRICE: ..... $

Current CONTRACT PRICE adjusted by previous CHANGE ORDER(S) ..... $

The new CONTRACT PRICE including this CHANGE ORDER will be ..... $

The CONTRACT TIME will be increased by _____ calendar days.

The date for Substantial Completion will be _____, 20___.

The Contractor agrees to furnish all labor and materials and perform all work as necessary to complete the change order items for the price named herein, which includes all supervision and miscellaneous costs. This change order constitutes full and mutual accord and satisfaction for all time and all costs related to this change. By acceptance of this change order the Contractor agrees that the change order represents an equitable adjustment to the Contract, and further agrees to waive all right to file a claim arising out of or as a result of this change. This document will become a supplement to the Contract, and all provisions will apply hereto, upon approval by the Owner.

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CHANGE ORDER
(CONTINUED)

Change Order No. _____

Date: _____

Page ___ of ___

Recommended:

Engineer -	Date

Accepted:

Contractor -	Date

Approved:

Owner - Jordan Valley Water Conservancy District	Date

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CONTRACTOR'S CERTIFICATE
OF
SUBSTANTIAL COMPLETION

OWNER:	ENGINEER:
Jordan Valley Water Con. District 8215 South 1300 West West Jordan, Utah 84088 801-565-4300	Heath Engineering 377 West 800 North Salt Lake City, Utah 84103 801-597-3619

PROJECT: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

ATTENTION: _____

FROM: _____
Firm or Corporation

This is to certify that I,_____ am an authorized official of _____ working in the capacity of_____ _____and have been properly authorized by said firm or corporation to sign the following statements pertaining to the subject contract:

I know of my own personal knowledge, and do hereby certify, that the work of the contract described above has been substantially performed and all materials used and installed to date are in accordance with, and in conformity to, the contract drawings and specifications. A list of all incomplete work is attached.

The Contractor hereby releases the Owner and its agents from all claims of and liability to the Contractor for anything done or furnished for or relating to the work, as further provided in Article 14.08B of the General Conditions, except demands against the Owner for the remainder of progress payments retained to date, and unresolved written claims prior to this date.

The contract work is now substantially complete, ready for its intended use, and ready for your inspection. You are requested to issue a Certificate of Substantial Completion.

SIGNATURE: _____

DATE: _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CONTRACTOR'S CERTIFICATE
OF
FINAL COMPLETION

OWNER:	ENGINEER:
Jordan Valley Water Con. District 8215 South 1300 West West Jordan, Utah 84088 801-565-4300	Heath Engineering 377 West 800 North Salt Lake City, Utah 84103 801-597-3619

PROJECT: SWGWTP AND EDUCATION BUILDING HVAC IMPROVEMENTS PROJECT.

ATTENTION: Project Representative: _____

FROM: _____
Firm or Corporation

This is to certify that I, _____ am an authorized official of _____ working in the capacity of_____ _____and have been properly authorized by said firm or corporation to sign the following statements pertaining to the subject contract:

I know of my own personal knowledge, and do hereby certify, that the work of the contract described above has been performed and all materials used and installed to date are in accordance with, and in conformity to, the contract drawings and specifications.

The Contract work is now complete in all parts and requirements, excepting the attached list of minor deficiencies and the reasons for each being incomplete to date, for which exemption from final payment requirements is requested in conformance to Article 14.09A of the General Conditions of our Contract (if no exemptions requested, write "none") _____. The work is now ready for your final inspection. The following items required from the Contractor prior to application for final payment (such as O & M Manuals, guarantees, record drawings, etc.) are submitted herewith, if any:

_____

_____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

I understand that neither the issuance by the Engineer of a Notice of Completion, nor the acceptance thereof by the Owner, shall operate as a bar or claim against the Contractor under the terms of the guarantee provisions of the Contract Documents.

SIGNATURE: _____

DATE: _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CONSENT OF SURETY FOR FINAL PAYMENT

PROJECT NAME: SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT.

LOCATION: _____

TYPE OF CONTRACT: _____

AMOUNT OF CONTRACT: _____

In accordance with the provisions of the above-named contract between the Owner and the Contractor, the following named surety:

_____

_____

_____

on the Payment Bond of the following named Contractor:

_____

_____

_____

hereby approves of final payment to the Contractor, and further agrees that said final payment to the Contractor shall not relieve the Surety Company named herein of any of its obligations to the following named Owner (as set forth in said Surety company's bond):

_____

_____

IN WITNESS WHEREOF, the Surety Company has hereunto set its hand and seal this _____ day of _____, 20___.

_____
(Name of Surety Company)

_____
(Signature of Authorized Representative)

_____
(Name of Authorized Representatives)

_____
(Title)

JORDAN VALLEY WATER CONSERVANCY DISTRICT

AFFIDAVIT OF PAYMENT

To All Whom It May Concern:

WHEREAS, the undersigned has been employed by the Jordan Valley Water Conservancy District to furnish labor and materials under a contract dated _____ for the project entitled SWGWTP AND EDUCATION CENTER HVAC IMPROVEMENTS PROJECT, in the County of Salt Lake, State of Utah, of which Jordan Valley Water Conservancy District is the Owner.

NOW, THEREFORE, this _____ day of _____, 20__, the undersigned, as the Contractor for the above-named Contract pursuant to the Conditions of the Contract hereby certifies that, except as listed below, he has paid in full or has otherwise satisfied all obligations for all materials and equipment furnished, for all work, labor, and services performed, and for all known indebtedness and claims against the Contractor for damages arising in any manner in connection with the performance of the Contract referenced above for which the Owner or his property might in any way be held responsible.

EXCEPTIONS: (If none, write "None". If required by the Owner, the Contractor shall furnish bond satisfactory to the Owner for each Exception.)

_____

Contractor (Name of sole ownership, corporation or partnership)

(affix corporate seal here)

_____

(Signature of Authorized Representative)

Title: _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents the following terms have the meanings indicated:

Addenda - Written or graphic instruments issued prior to the opening of Bids which make additions, deletions, or revisions to the Contract Documents.

Agreement - The written contract between the OWNER and the CONTRACTOR for the performance of the WORK pursuant to the Contract Documents. Documents incorporated into the contract by reference become part of the contract and of the Agreement.

Application for Payment - The form furnished by the ENGINEER and completed by the CONTRACTOR to request progress or final payment including supporting documentation to substantiate the amounts for which payment is requested.

Bonds - Performance, and Payment Bonds and other instruments which protect against loss due to inability or refusal of the CONTRACTOR to perform pursuant to the Contract Documents.

Change Order - A document recommended by the ENGINEER, which is signed by the CONTRACTOR and the OWNER and authorizes an addition, deletion, or revision in the WORK, or an adjustment in the Contract Price or the Contract Time, issued on or after the Effective Date of the Agreement.

Contract Documents - Information and Instructions, forms (including the Schedule of Prices and all required certificates and affidavits), Agreement, Performance Bond, Payment Bond, General Conditions, Supplemental General Conditions, Technical Specifications, Drawings and all Addenda and Change Orders executed pursuant to the provisions of the Contract Documents.

Contract Price - The total monies payable by the OWNER to the CONTRACTOR under the terms and conditions of the Contract Documents.

Contract Time - The number of successive Days stated in the Contract Documents for the completion of the WORK. The Contract Time begins to run on the date specified in the Notice to Proceed.

CONTRACTOR - The person, firm, or corporation with whom the OWNER has executed the Agreement.

Cost Proposal - The offer or proposal of the pipeline installation subcontractor to the CONTRACTOR to provide the work required under these Contract Documents.

Day - A calendar day of 24 hours measured from midnight to the next midnight.

Defective Work - Work that: is unsatisfactory, faulty, or deficient; does not conform to the Contract Documents; does not meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents; has been damaged prior to the ENGINEERS's recommendation of final payment.

Drawings - The drawings, plans, maps, profiles, diagrams, and other graphic representations which show the character, location, nature, extent, and scope of the WORK.

Effective date of the Agreement - The date indicated in the Agreement on which it was executed, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

ENGINEER - The person, firm, or corporation named as such in the Contract Documents.

Field Order - A written order issued by the ENGINEER which may or may not involve a change in the WORK.

Laws and Regulations; Laws or Regulations - Laws, rules, regulations, ordinances, codes, and/or orders promulgated by a lawfully constituted body authorized to issue such Laws and Regulations.

Notice of Award - The OWNER's written notice to the apparent successful Bidder stating that upon compliance with the conditions precedent enumerated therein by the apparent successful Bidder within the time specified, the OWNER will enter into the Agreement.

Notice to Proceed - The OWNER's written notice to the CONTRACTOR authorizing the CONTRACTOR to proceed with the work and establishing the date of commencement of the Contract Time.

OWNER - The Jordan Valley Water Conservancy District.

Partial Utilization - Placing a portion of the WORK in service for the purpose for which it is intended (or a related purpose) before reaching Substantial Completion of the WORK.

Project - A unit of total construction of which the WORK to be provided under the Contract Documents, may be the whole, or a part thereof.

Project Representative - The authorized representative of the ENGINEER who is assigned to the site or any part thereof.

Proposer - Any person, firm or corporation submitting a proposal for the work.

Schedule of Prices - The offer or proposal of the CONTRACTOR setting forth the price or prices for the work to be performed.

Shop Drawings - All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for the CONTRACTOR to illustrate some portion of WORK and all illustrations, brochures, standard schedules, performance charts, instruction, and diagrams to illustrate material or equipment for some portion of the WORK.

Specifications - (Same definition as for Technical Specifications hereinafter).

Subcontractor - An individual, firm, or corporation having a direct contract with the CONTRACTOR or with any other Subcontractor for the performance of a part of the WORK at the site.

Substantial Completion - That state of construction when the WORK has progressed to the point where, in the opinion of the ENGINEER as evidenced by the Certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the WORK can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to any work refer to substantial completion thereof.

Supplementary General Conditions - The part of the Contract Documents which make additions, deletions, or revisions to these General Conditions.

Supplier - A manufacturer, fabricator, supplier, distributor, materialman, or vendor.

Technical Data - The factual information contained in reports describing physical conditions, including exploration method, plans, logs, laboratory test methods and factual data. Technical Data does not include conclusions, interpretations, interpolations, extrapolations or opinions contained in reports or reached by the CONTRACTOR.

Technical Specifications - Those portions of the Contact Documents consisting of the written technical descriptions of products and execution of the WORK.

Underground Utilities - All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments and any encasements containing such facilities which have been installed under ground to furnish any of the following services or

materials: water, sewage and drainage removal, electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, traffic, or other control systems.

WORK - The entire construction required to be furnished under the Contract Documents. WORK is the result of performing services, furnishing labor and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

GENERAL CONDITIONS

ARTICLE 2 - PRELIMINARY MATTERS

2.01 DELIVERY OF BONDS/INSURANCE CERTIFICATES

A. The CONTRACTOR shall deliver to the OWNER the Agreement, Bonds, Insurance Policies and Certificates required by the Contract Documents within ten (10) days after receiving the Notice of Award from the OWNER.

2.02 COPIES OF DOCUMENTS

A. The OWNER shall furnish the CONTRACTOR 5 copies of the Contract Documents, together with 5 sets of full-scale Drawings. Additional quantities of the Contract Documents will be furnished at reproduction cost.

2.03 STARTING THE PROJECT

A. The CONTRACTOR shall begin construction of the WORK within 10 days after the commencement date stated in the Notice to Proceed, but shall not commence construction prior to the commencement date.

2.04 BEFORE STARTING CONSTRUCTION

A. Before undertaking each part of the WORK, the CONTRACTOR shall carefully study and compare the Contract Documents to check and verify pertinent figures and dimensions shown thereon with all applicable field measurements. The CONTRACTOR shall promptly report in writing to the ENGINEER any conflict, error, or discrepancy which the CONTRACTOR may discover and shall obtain a written interpretation or clarification from the ENGINEER before proceeding with any work affected thereby.

B. The CONTRACTOR shall submit to the ENGINEER for review those documents called for in each section of the Technical Specifications.

2.05 PRECONSTRUCTION CONFERENCE

A. The CONTRACTOR shall attend a preconstruction conference with the OWNER, the ENGINEER and others as appropriate to discuss the construction of the WORK in accordance with the Contract Documents.

2.06 FINALIZING SCHEDULES

A. At least 7 days before the CONTRACTOR's submittal of its first Application for Payment, the CONTRACTOR, the ENGINEER, and others as appropriate will meet to finalize the schedules submitted in accordance with the Technical Specifications.

GENERAL CONDITIONS

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 INTENT

A. The Contract Documents comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK. The Contract Documents are complementary, what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the place of the Project.

B. It is the intent of the Contract Documents to describe the WORK, functionally complete, to be constructed in accordance with the Contract Documents. All work, materials, or equipment that may be reasonably inferred from the Contract Documents as being required to produce the completed work shall be supplied whether or not specifically called for. When words which have a well-known technical or trade meaning are used to describe work, materials, or equipment such words shall be interpreted in accordance with that meaning. Reference to standard specifications, manuals, or codes or any technical society, organization, or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual, or code (whether or not specifically incorporated by reference in the Contract Documents) shall be effective to change the duties and responsibilities of the OWNER, the CONTRACTOR, or the ENGINEER or any of their consultants, agents, or employees from those set forth in the Contract Documents.

C. If, during the performance of the WORK, the CONTRACTOR finds a conflict, error or discrepancy in the Contract Documents, the CONTRACTOR shall immediately report it to the ENGINEER in writing and before proceeding with the work affected thereby. The ENGINEER shall then make a written interpretation, clarification, or correction from the ENGINEER.

3.02 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

A. In resolving conflicts resulting from conflicts, errors, or discrepancies in any of the Contract Documents, the order of precedence shall be as follows:

1. Change Orders
2. Agreement
3. Addenda
4. Contractor's Bid (Bid Form)
5. Supplemental General Conditions
6. Notice Inviting Bids
7. Instructions to Bidders
8. General Conditions
9. Technical Specifications
10. Referenced Standard Specifications
11. Drawings

B. With reference to the Drawings the order of precedence is as follows:

1. Figures govern over scaled dimensions
2. Detail drawings govern over general drawings
3. Addenda/change order drawings govern over general drawings
4. Contract Drawings govern over standard drawings

3.03 AMENDING AND SUPPLEMENTING CONTRACT DOCUMENTS

A. The Contract Documents may be amended by a Change Order (pursuant to Article 10) to provide for additions, deletions or revisions in the WORK or to modify terms and conditions.

3.04 REUSE OF DOCUMENTS

A. Neither the CONTRACTOR, Subcontractor, Supplier, nor any other person or organization performing any of the WORK under a contract with the OWNER shall have or acquire any title to or ownership rights in any of the Drawings, Technical Specifications, or other documents used on the WORK, and they shall not reuse any of them on the extensions of the Project or any other project without written consent.

GENERAL CONDITIONS

ARTICLE 4 - AVAILABILITY OF LANDS; PHYSICAL CONDITIONS: REFERENCE POINTS

4.01 AVAILABILITY OF LANDS

A. The OWNER shall furnish the lands, rights-of-way and easements upon which the WORK is to be performed and for access thereto, together with other lands designated for the use of the CONTRACTOR in the Contract Documents. Easements for permanent structures or permanent changes in existing major facilities will be obtained and paid for by the OWNER, unless otherwise provided in the Contract Documents. Nothing contained in the Contract Documents shall be interpreted as giving the CONTRACTOR exclusive occupancy of the lands or rights-of-way provided. The CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment. The CONTRACTOR shall not enter upon nor use any property not under the control of the OWNER until a written temporary construction easement agreement has been executed by the CONTRACTOR and the property owner, and a copy of the easement furnished to the ENGINEER prior to its use. Neither the OWNER nor the ENGINEER shall be liable for any claims or damages resulting from the CONTRACTOR's unauthorized trespass or use of any properties.

4.02 PHYSICAL CONDITIONS - SUBSURFACE AND EXISTING STRUCTURES

A. Explorations and Reports: The paragraph entitled "Physical Conditions" of the Supplementary General Conditions identifies exploration reports and subsurface conditions tests at the site that have been utilized by the ENGINEER in the preparation of the Contract Documents. The CONTRACTOR may rely upon the accuracy of the Technical Data contained in these reports. The CONTRACTOR is responsible for the interpretation, extrapolation or interpolation of all technical as well as nontechnical data and its reliance on the completeness, opinions and interpretation of the reports.

B. Existing Structures: The paragraph entitled "Physical Conditions" of the Supplementary General Conditions identifies the drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground Utilities referred to in Paragraph 4.04 herein) which are at or contiguous to the site that have been utilized by the ENGINEER in the preparation of the Contract Documents. The CONTRACTOR is responsible for the interpretation, extrapolation or interpolation of all technical as well as nontechnical data and its reliance on the completeness, opinions and interpretation of the reports.

4.03 DIFFERING SITE CONDITIONS

A. The CONTRACTOR shall notify the ENGINEER upon encountering any of the following unforeseen conditions, hereinafter called "differing site conditions," during the prosecution of the WORK. The CONTRACTOR's notice to the ENGINEER shall be in writing and delivered before the differing site conditions are disturbed, but in no event later than 14 days after their discovery.

1. Subsurface or latent physical conditions at the site of the WORK differing materially from those indicated, described, or delineated in the Contract Documents including those reports and documents discussed in Paragraph 4.02; and

2. Physical conditions at the site of the WORK of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents including those reports and documents discussed in Paragraph 4.02.

B. The ENGINEER will review the alleged differing site conditions, determine the necessity of obtaining additional explorations or tests with respect to verifying their existence and extent and advise the OWNER in writing of the ENGINEER's findings and conclusions.

C. If the OWNER concludes that because of newly discovered conditions a change in the Contract Documents is required, a Change Order will be issued as provided in Article 10 to reflect and document the consequences of the differing site conditions.

D. In each such case, an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, or any combination thereof, will be allowable to the extent that they are attributable to the differing site conditions. If the OWNER and the CONTRACTOR are unable to agree as to the amount or length of the Change Order, a claim may be made as provided in Articles 11 and 12.

E. The CONTRACTOR's failure to give written notice of differing site conditions within 14 days of their discovery and before they are disturbed shall constitute a waiver of all claims in connection therewith, whether direct or consequential in nature.

4.04 PHYSICAL CONDITIONS - UNDERGROUND UTILITIES

A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Utilities at or contiguous to the site are based on information and data furnished to the OWNER or the ENGINEER by the owners of Underground Utilities or by others. Unless it is expressly provided in the Supplementary General Conditions and/or the Section entitled "Protection and Restoration of Existing Facilities" of the Technical Specifications, the OWNER and the ENGINEER shall not be responsible for the accuracy or completeness of any Underground Utilities information or data. The CONTRACTOR's responsibility relating to underground utilities are: review and check all information and data, locate all Underground Utilities shown or indicated in the Contract Documents, coordinate the WORK with the owners of Underground Utilities during construction, the safeguard and protect the of Underground Utilities, and repair any damage to Underground Utilities resulting from the WORK. The cost of all these activities will be considered as having been included in the Contact Price.

B. Not Shown or Indicated: If an Underground Utility not shown or indicated in the Contract Documents is uncovered or revealed at or contiguous to the site and which the CONTRACTOR could not reasonably have been expected to be aware of, the CONTRACTOR shall give written notice to the OWNER of that utility and the ENGINEER, specifying the location of the utility in question.

4.05 REFERENCE POINTS

A. The ENGINEER will provide one bench mark, near or on the site of the WORK, and will provide two points near or on the site to establish a base line for use by the ENGINEER for alignment control. Unless otherwise specified in the Technical Specifications, the CONTRACTOR shall furnish all other lines, grades, and bench marks required for proper execution of the WORK.

B. The CONTRACTOR shall preserve all bench marks, stakes, and other survey marks. In case of their removal or destruction by its own employees or by its subcontractor's employees, the CONTRACTOR shall be responsible for the accurate replacement of reference points by professionally qualified personnel at no additional cost to the OWNER.

GENERAL CONDITIONS

ARTICLE 5 - BONDS AND INSURANCE

5.01 PERFORMANCE AND OTHER BONDS

A. The CONTRACTOR shall furnish Performance and Payment Bonds, each in the amount set forth in the Supplementary General Conditions as security for the faithful performance and payment of all the CONTRACTOR's obligations under the Contract Documents. All insurance companies, sureties, and bond companies shall have an AM Best rating of A- or better, with a Financial Size Category of XII or better. Sureties shall also be listed on the Department of the Treasury's Circular 570, with an acceptable underwriting limitation limit. The Performance Bond shall remain in effect at least until one year after the date of Notice of Completion, except as otherwise provided by Law or Regulation or by the Contract Documents. After the ENGINEER issues the Notice of Completion, the amount of the Performance Bond may be reduced to 10 percent of the Contract Price, or $1,000, whichever is greater. The CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary General Conditions.

B. If the surety on any Bond furnished by the CONTRACTOR is declared a bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the WORK is located, the CONTRACTOR shall within 7 days after written approval by the OWNER of a substitute Bond and Surety substitute the approved Bond and Surety.

5.02 INSURANCE

A. The CONTRACTOR shall purchase and maintain the insurance required under this paragraph. All insurance companies, sureties, and bond companies shall have an AM Best rating of A- or better, with a Financial Size Category of XII or better. Sureties shall also be listed on the Department of the Treasury's Circular 570, with an acceptable underwriting limitation limit. This insurance shall include the specific coverages set out herein and be written for not less than the limits of liability and coverages provided in the Supplementary General Conditions, or required by law, whichever is greater. The CONTRACTOR's liabilities under the Agreement shall not be deemed limited in any way to the insurance coverage required.

B. The CONTRACTOR shall furnish the OWNER and ENGINEER with certificates indicating the type, amount, class of operations covered, effective dates and expiration dates of all policies. All insurance policies purchased and maintained (or the certificates or other evidence thereof) shall contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 30 days' prior written

notice has been given to the OWNER by certified mail. All insurance shall remain in effect until the ENGINEER issues the Notice of Completion and at all times thereafter when the CONTRACTOR may be correcting, removing, or replacing defective work in accordance with Paragraph 13.06 or completing punch list items required by the Notice of Completion. In addition, the insurance required herein (except for Worker's Compensation and Employer's Liability) shall name the OWNER, the ENGINEER, and their officers, agents, and employees as "additional insured" under the policies.

1. Workers' Compensation and Employer's Liability: This insurance shall protect the CONTRACTOR against all claims under applicable state workers' compensation laws. 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. This policy shall include an "all states" endorsement. The CONTRACTOR shall require each subcontractor similarly to provide Workers' Compensation Insurance for all of the latter's employees to be engaged in the WORK unless its employees are covered by the protection afforded by the CONTRACTOR's Workers' Compensation Insurance. In the event a class of employees is not protected under the Workers' Compensation Statute, the CONTRACTOR or Subcontractor, as the case may be, shall provide adequate employer's liability insurance for the protection of its employees not protected under the statute.

2. Comprehensive General Liability: This insurance shall be written in comprehensive form and shall protect the CONTRACTOR against all claims arising from injuries to persons other than its employees and damage to property of the OWNER or others arising out of any act or omission of the CONTRACTOR or its agents, employees or subcontractors. The policy shall include the following endorsements: (1) Protective Liability endorsement to insure the contractual liability assumed by the CONTRACTOR under the indemnification provisions in these General Conditions; (2) Broad Form Property Damage endorsement; (3) Personal Injury endorsement to cover personal injury liability for intangible harm. The Comprehensive General Liability coverage shall contain no exclusion relative to blasting, explosion, collapse of building, or damage to underground structures.

3. Comprehensive Automobile Liability: This insurance shall be written in comprehensive form. The policy shall protect the CONTRACTOR against all claims for injuries to employees, members of the public and

damage to property of others arising from the use of CONTRACTOR's motor vehicles, whether they are owned, non-owned, or hired, and whether used or operated on or off the site. The motor vehicle insurance required under this paragraph shall include: (a) motor vehicle liability coverage; (b) personal injury protection coverage and benefits; and (c) uninsured motor vehicle coverage.

4. Subcontractor's Insurance: The CONTRACTOR shall require each of its subcontractors to procure and to maintain Comprehensive General Liability Insurance and Comprehensive Automobile Liability Insurance of the type and in the amounts specified in the Supplementary General Conditions or insure the activities of its subcontractors in the CONTRACTOR's own policy, in like amount.

5. Builder's Risk: This insurance shall be of the "all risk" type, shall be written in completed value form, and shall protect the CONTRACTOR, the OWNER, and the ENGINEER against damage to buildings, structures, materials and equipment. The amount of this insurance shall not be less than the insurable value of the WORK at completion. Builder's risk insurance shall provide for losses to be payable to the CONTRACTOR, the OWNER, and the ENGINEER as their interests may appear. The policy shall contain a provision that in the event of payment for any loss under the coverage provided, the insurance company shall have no rights of recovery against the CONTRACTOR, the OWNER, and the ENGINEER. The Builder's Risk policy shall insure against all risks of direct physical loss or damage to property from any external cause including flood and earthquake. Allowable exclusions, if any, shall be as specified in the Supplementary General Conditions.

GENERAL CONDITIONS

ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

6.01 SUPERVISION AND SUPERINTENDENCE

A. The CONTRACTOR shall supervise and direct the WORK competently and efficiently, devoting the attention and applying the skills and expertise necessary to perform the WORK in accordance with the Contract Documents. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction and safety precautions and programs incidental thereto. The CONTRACTOR shall be responsible to see that the finished WORK complies accurately with the Contract Documents.

B. The CONTRACTOR shall employ the Superintendent named in "Information Required of Bidder" on the work site at all times during the progress of the WORK. The superintendent shall not be replaced without the OWNER's written consent. The superintendent will be the CONTRACTOR's representative at the site and shall have authority to act on behalf of the CONTRACTOR. All communications given to the superintendent shall be as binding as if given to the CONTRACTOR. The CONTRACTOR shall issue all its communications to the OWNER through the ENGINEER.

C. The CONTRACTOR's superintendent shall be present at the site of the WORK at all times while work is in progress. Failure to observe this requirement shall be considered suspension of the WORK by the CONTRACTOR until the superintendent is again present at the site.

6.02 LABOR, MATERIALS, AND EQUIPMENT

A. The CONTRACTOR shall provide skilled, competent and suitably qualified personnel to survey and lay out the WORK and perform construction as required by the Contract Documents. When required in writing by the OWNER or ENGINEER, the CONTRACTOR or any subcontractor shall discharge any person who is, in the opinion of the OWNER or ENGINEER, incompetent, disorderly, or otherwise unsatisfactory and shall not again employ the discharged person on the WORK without the consent of the OWNER or ENGINEER. The CONTRACTOR shall at all times maintain good discipline and order at the site.

B. Except in connection with the safety or protection of persons the WORK, or property at the site or adjacent thereto, all work at the site shall be performed during regular working hours, and the CONTRACTOR will not permit overtime work or the performance of work on Saturday, Sunday or any legal holiday without the OWNER's written consent given after prior written notice

to the ENGINEER. Except as otherwise provided in this Paragraph, the CONTRACTOR shall receive no additional compensation for overtime work, i.e., work in excess of 8 hours in any one calendar day or 40 hours in any one calendar week, even though such overtime work may be required under emergency conditions and may be ordered by the ENGINEER in writing. Additional compensation will be paid the CONTRACTOR for overtime work in the event extra work is ordered by the ENGINEER and the Change Order specifically authorizes the use of overtime work, but only to the extent that the CONTRACTOR pays overtime wages on a regular basis being paid by for overtime work of a similar nature in the same locality.

C. All costs of inspection and testing performed during overtime work approved solely for the convenience of the CONTRACTOR shall be borne by the CONTRACTOR. The OWNER shall have the authority to deduct the costs of all inspection and testing from any partial payments otherwise due to the CONTRACTOR.

D. Unless otherwise specified in the Contract Documents, the CONTRACTOR shall furnish, erect, maintain and remove the construction plant, and temporary works and assume full responsibility for all materials, equipment, labor, transportation, construction equipment, machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities and all other facilities and incidentals necessary for the furnishing, performance testing, start-up and completion of the WORK.

E. All materials and equipment incorporated into the WORK shall be of new and good quality, except as otherwise provided in the Contract Documents. If required by the ENGINEER, the CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. The CONTRACTOR shall apply, install, connect, erect, use, clean, and condition all material and equipment in accordance with the instructions of the manufacturer and Supplier except as otherwise provided in the Contract Documents.

6.03 ADJUSTING PROGRESS SCHEDULE

A. The CONTRACTOR shall submit any adjustments in the progress schedule to the ENGINEER for acceptance in accordance with the provisions for "Contractor Submittals" in the Technical Specifications.

6.04 SUBSTITUTES OR "OR-EQUAL" ITEMS

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or “or-equal” item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to ENGINEER for review under the circumstances described below:

1. “Or-Equal” Items: If in ENGINEER’s sole discretion an item of material or equipment proposed by CONTRACTOR is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by ENGINEER as an “or-equal” item, in which case review and approval of the proposed item may, in ENGINEER’s sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this paragraph 6.04.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment ENGINEER determines that: (i) it is a least equal in quality, durability, appearance, strength, and design characteristics; (ii) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole, and;

b. CONTRACTOR certifies that: (i) there is no increase in cost to the OWNER; and (ii) it will conform substantially, even with deviations, to the detailed requirements of the item named in the Contract Document.

2. Substitute Items

a. If in ENGINEER’s sole discretion an item of material or equipment proposed by CONTRACTOR does not qualify as an “or-equal” item under paragraph 6.04.A.1, it will be considered a proposed substitute item.

b. CONTRACTOR shall submit sufficient information as provided below to allow ENGINEER to determine that the item of material or

equipment proposed is essentially equivalent to that named and an acceptable substitute therefore. Requests for review of proposed substitute items of material or equipment will not be accepted by ENGINEER from anyone other than CONTRACTOR.

c. The procedure for review by ENGINEER will be as set forth in paragraph 6.04.A.2.d, as supplemented in the Technical Specifications and as ENGINEER may decide is appropriate under the circumstances.

d. CONTRACTOR shall first make written application to ENGINEER for review of a proposed substitute item of material or equipment that CONTRACTOR seeks to furnish or use. The application shall certify that the proposed substitute item will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified, and be suited to the same use as that specified. The application will state the extent, if any, to which the use of the proposed substitute item will prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not use of the proposed substitute item will require a change in any of the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) to adapt the design to the proposed substitute item, and whether or not incorporation or use of the substitute item is subject to payment of any license fee or royalty. All variations of the proposed substitute item from that specified will be identified in the application, and available engineering, sales, maintenance, repair, and replacement services will be indicated. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change, all of which will be considered by ENGINEER in evaluating the proposed substitute item. ENGINEER may require CONTRACTOR to furnish additional data about the proposed substitute item.

B. Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is shown or indicated in and expressly required by the Contract Documents, CONTRACTOR may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by ENGINEER. CONTRACTOR shall submit sufficient information to allow ENGINEER, in

ENGINEER's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The procedure for review by ENGINEER will be similar to that provided in subparagraph 6.04.A.2.

C. Engineer's Evaluation: ENGINEER will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to paragraphs 6.04.A and 6.04.B. ENGINEER will be the sole judge of acceptability. No "or-equal" or substitute will be ordered, installed or utilized until ENGINEER's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." ENGINEER will advise CONTRACTOR in writing of any negative determination.

D. Special Guarantee: OWNER may require CONTRACTOR to furnish at CONTRACTOR's expense a special performance guarantee or other surety with respect to any substitute.

E. ENGINEER's Cost Reimbursement: ENGINEER will record time required by ENGINEER and ENGINEER's Consultants in evaluating substitute proposed or submitted by CONTRACTOR pursuant to paragraphs 6.04.A.2 and 6.04.B and in making changes in the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) occasioned thereby. Whether or not ENGINEER approves a substitute item so proposed or submitted by CONTRACTOR, CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER's Consultants for evaluation each such proposed substitute.

F. CONTRACTOR's EXPENSE: CONTRACTOR shall provide all data in support of any proposed substitute or "or-equal" at CONTRACTOR's expense.

6.05 CONCERNING SUBCONTRACTORS, SUPPLIERS, AND OTHERS

A. The CONTRACTOR shall be responsible to the OWNER and the ENGINEER for the acts and omissions of its subcontractors and their employees to the same extent as the CONTRACTOR is responsible for the acts and omissions of its own employees. Nothing contained in this paragraph shall create any contractual relationship between any subcontractor and the OWNER or the ENGINEER nor relieve the CONTRACTOR of any liability or obligation under the Agreement.

6.06 PERMITS

A. Unless otherwise provided in the Supplementary General Conditions, the CONTRACTOR shall obtain and pay for all construction permits and licenses from the agencies having jurisdiction, including furnishing the insurance and bonds required by such agencies. The costs incurred by the CONTRACTOR in compliance with this paragraph shall not be made the basis for claims for additional compensation. The OWNER shall assist the CONTRACTOR, when necessary, in obtaining such permits and licenses. The CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the WORK, which are applicable at the time of opening of Bids, including all utility connection charges for utilities required by the WORK.

B. The CONTRACTOR shall pay all license fees and royalties and assume all costs when any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others when issued in the construction of the WORK or incorporated into the WORK. If a particular invention, design, process, product, or device is specified in the Contract Documents for incorporation into or use in the construction of the WORK and if to the actual knowledge of the OWNER or the ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of these rights shall be disclosed by the OWNER in the Contract Documents. The CONTRACTOR shall indemnify, defend and hold harmless the OWNER and the ENGINEER and anyone directly or indirectly employed by either of them from and against all claims, damages, losses, and expenses (including attorneys' fees and court costs) arising out of any infringement of patent rights or copyrights incident to the use in the performance of the WORK or resulting from the incorporation in the WORK of any invention, design, process, product, or device not specified in the Contract Documents.

6.07 LAWS AND REGULATIONS

A. The CONTRACTOR shall observe and comply with all federal, state, and local laws, ordinances, codes, orders, and regulations which in any manner affect those engaged or employed on the WORK, the materials used in the WORK, or the conduct of the WORK. If any discrepancy or inconsistency should be discovered in the Contract Documents in relation to any law, ordinance, code, order, or regulations, the CONTRACTOR shall report the same in writing to the ENGINEER. The CONTRACTOR shall indemnify, defend and hold harmless the OWNER, the ENGINEER and their officers, agents, and employees against all claims and from violation of any law, ordinance, code, order, or regulation, whether by CONTRACTOR or by its employees or subcontractors. Any particular law or regulation specified or

referred to elsewhere in the Contract Documents shall not in any way limit the obligation of the CONTRACTOR to comply with all other provisions of federal, state, and local laws and regulations. Where an individual State act on occupational safety and health standards has been approved by Federal authority, then the provision of said State act shall control.

6.08 EQUAL OPPORTUNITY

A. The Contractor agrees to abide by: the provisions of Title VII of the Civil Rights Act of 1964 (42USC § § 2000e et seq.), which prohibits discrimination against any employee or applicant for employment on the basis of race, religion, color, or national origin; Executive Order No. 11246, as amended, which prohibits discrimination on the basis of sex; 45 CFR 90, which prohibits discrimination on the basis of age; Section 504 of the Rehabilitation Act of 1973, (42 USC § 794), which prohibits discrimination on the basis of handicap; Utah Executive Order dated June 30, 1989, which prohibits sexual harassment in the workplace; and the Americans with Disabilities Act (42 USC § § 12111 et seq.), which prohibits discrimination against qualified employees and applicants with a disability.

6.09 TAXES

A. The CONTRACTOR shall pay all sales, consumer, use, and other similar taxes required to be paid by the CONTRACTOR in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the WORK.

6.10 USE OF PREMISES

A. The CONTRACTOR shall confine construction equipment, stored materials and equipment, and other operations of workers to (1) the Project site, (2) the land and areas identified for the CONTRACTOR's use in the Contract Documents, and (3) other lands whose use is acquired by Laws and Regulations, rights-of-way, permits, and easements. The CONTRACTOR shall be fully responsible to the owner and occupant of such lands for any damage to the lands or areas contiguous thereto, resulting from the performance of the WORK or otherwise. Should any claim be made against the OWNER or the ENGINEER by owner or occupant of lands because of the performance of the WORK, the CONTRACTOR shall promptly settle the claim by agreement, or resolve the claim through litigation. The CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify, defend, and hold the OWNER and the ENGINEER harmless from and against all claims, damages, losses, and expenses (including, but not limited to, fees of engineers, architects, attorneys, and other professionals and court costs) arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any owner or occupant of land against the OWNER or the ENGINEER to the extent the claim is based or arises out of the CONTRACTOR's performance of the WORK.

6.11 SAFETY AND PROTECTION

A. The CONTRACTOR shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the WORK. The CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. All employees on the WORK and other persons and organizations who may be affected thereby.

2. All the WORK and materials and equipment to be incorporated therein, whether in storage on or off the site; and

3. Other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

B. The CONTRACTOR shall comply with all applicable Laws and Regulations (whether referred to herein or not) of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury, or loss and shall erect and maintain all necessary safeguards for such safety and protection. The CONTRACTOR shall notify owners of adjacent property and utilities when prosecution of the WORK may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. Unless the CONTRACTOR otherwise designates in writing a different individual as the responsible individual, the CONTRACTOR's superintendent shall be CONTRACTOR's representative at the site whose duty shall be the prevention of accidents.

6.12 SHOP DRAWINGS AND SAMPLES

A. After checking and verifying all field measurements and after complying with the applicable procedures specified in the Technical Specifications, the CONTRACTOR shall submit all shop drawings to the ENGINEER for review and approval in accordance with the approved schedule for shop drawings submittals specified in the Technical Specifications.

B. The CONTRACTOR shall also submit to the ENGINEER for review and approval all samples in accordance with the approved schedule of sample submittals specified in the Technical Specifications.

C. Before submitting shop drawings or samples, the CONTRACTOR shall determine and verify all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereto and review or coordinate each shop drawing or sample with other shop drawings and samples and with the requirements of the WORK and the Contract Documents.

6.13 CONTINUING THE WORK

A. The CONTRACTOR shall carry on the WORK and adhere to the progress schedule during all disputes or disagreements with the OWNER. No work shall be delayed or postponed pending resolution of any dispute or disagreement, except as the CONTRACTOR and the OWNER may otherwise mutually agree in writing.

6.14 INDEMNIFICATION

A. To the fullest extent permitted by Laws and Regulations, the CONTRACTOR shall indemnify, defend, and hold harmless the OWNER, the ENGINEER, and their officers, agents, and employees, against and from all claims and liability arising under or by reason of the Agreement or any performance of the WORK, but not from the sole negligence or willful misconduct of the OWNER and/or the ENGINEER. Such indemnification by the CONTRACTOR shall include but not be limited to the following:

1. Liability or claims resulting directly or indirectly from the negligence or carelessness of the CONTRACTOR or its agents in the performance of the WORK, or in guarding or maintaining the same, or from any improper materials, implements, or appliances used in its construction, or by or on account of any act or omission of the CONTRACTOR or its agents;

2. Liability or claims arising directly or indirectly from or based on the violation of any law, ordinance, regulation, order, or decree, whether by the CONTRACTOR or its agents;

3. Liability or claims arising directly or indirectly from the use or manufacture by the CONTRACTOR, its agents, or the OWNER in the performance of this Agreement of any copyrighted or uncopyrighted composition, secret process, patented or unpatented invention, article, or appliance, unless otherwise specifically stipulated in this Agreement.

4. Liability or claims arising directly or indirectly from the breach of any warranties, whether express or implied, made to the OWNER or any other parties by the CONTRACTOR or its agents;

5. Liabilities or claims arising directly or indirectly from the willful misconduct of the CONTRACTOR or its agents; and,

6. Liabilities or claims arising directly or indirectly from any breach of the obligations assumed herein by the CONTRACTOR.

B. The CONTRACTOR shall reimburse the OWNER, and the ENGINEER for all costs and expense, (including but not limited to fees and charges of engineers, architects, attorneys, and other professional and court costs) incurred by the OWNER, and the ENGINEER in enforcing the provisions of this Paragraph.

C. The indemnification obligation under this Paragraph shall not be limited in any way by any limitation of the amount or type of damages, compensation, or benefits payable by or for the CONTRACTOR or any such subcontractor or other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts.

6.15 CONTRACTOR'S DAILY REPORTS

A. The CONTRACTOR shall complete a daily report indicating manpower, major equipment, subcontractors, weather conditions, etc., involved in the performance of the WORK. The daily report shall be completed on forms prepared by the CONTRACTOR and acceptable to the ENGINEER, and shall be submitted to the ENGINEER at the conclusion of each work day.

6.16 ASSIGNMENT OF CONTRACT

A. The CONTRACTOR shall not assign, sublet, sell, transfer, or otherwise dispose of the Agreement or any portion thereof, or its right, title, or interested therein, or obligations thereunder, without the written consent of the OWNER except as imposed by law. If the CONTRACTOR violates this provision, the Agreement may be terminated at the option of the OWNER. In such event, the OWNER shall be relieved of all liability and obligations to the CONTRACTOR and to its assignee or transferee, growing out of such termination.

ARTICLE 7 - OTHER WORK

7.01 RELATED WORK

A. The OWNER may perform other work related to the Project at the site by the OWNER's own forces, have other work performed by utility owners, or let other direct contracts for the performance of the other work which may contain General Conditions similar to these. If the fact that such other work is to be performed was not noted in the Contact Documents, written notice thereof will be given to the CONTRACTOR prior to commencing any other work.

B. The CONTRACTOR shall afford each utility owner and other contractor who is a party to a direct contract (or the OWNER, if the OWNER is performing the additional work with the OWNER's employees) proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of the other work. The CONTRACTOR shall properly connect and coordinate the WORK with the other work. The CONTRACTOR shall do all cutting, fitting, and patching of the WORK that may be required to make its several parts come together properly and integrate with the other work. The CONTRACTOR shall not endanger any work of others by cutting, excavating, or otherwise altering their work and shall only cut or alter their work with the written consent of the ENGINEER and the others whose work will be affected.

C. If the proper execution or results of any part of the CONTRACTOR's work depends upon the integration of work with the completion of other work by any other contractor or utility owner (or the OWNER), the CONTRACTOR shall inspect and report to the ENGINEER in writing all delays, defects, or deficiencies in the other work that renders it unavailable or unsuitable for proper integration with the CONTRACTOR's work. Except for the results or effects of latent or nonapparent defects and deficiencies in the other work, the CONTRACTOR's failure to report will constitute an acceptance of the other work as fit and proper for integration with the CONTRACTOR's work and as a waiver of any claim for additional time or compensation associated with the integration of the CONTRACTOR's work with the other work.

7.02 COORDINATION

A. If the OWNER contracts with others for the performance of other work on the Project at the site, a coordinator will be identified to the extent that the coordinator can be identified at this time, in the Supplementary General Conditions and delegated the authority and responsibility for coordination of the activities among the various contractors. The specific matters over which the coordinator has authority and the extent of the coordinator's authority and responsibility will be itemized in the Supplementary General Conditions or in a notice to the CONTRACTOR at such time as the identity of the coordinator is determined.

GENERAL CONDITIONS

ARTICLE 8 - OWNER'S RESPONSIBILITIES

8.01 COMMUNICATIONS

A. The OWNER shall issue all its communications to the CONTRACTOR through the ENGINEER.

8.02 PAYMENTS

A. The OWNER shall make payments to the CONTRACTOR as provided in Paragraphs 14.05 and 14.09.

8.03 LANDS, EASEMENTS, AND SURVEYS

A. The OWNER's duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. The OWNER shall identify and make available to the CONTRACTOR copies of exploration reports and subsurface conditions tests at the site and in existing structures which have been utilized by the ENGINEER in preparing the Drawings and Technical Specifications as set forth in Paragraph 4.02

8.04 CHANGE ORDERS

A. The OWNER shall execute approved Change Orders for the conditions described in Paragraph 10.01D.

8.05 INSPECTIONS AND TESTS

A. The OWNER's responsibility with respect to inspection, tests, and approvals is set forth in Paragraph 13.03B.

8.06 SUSPENSION OF WORK

A. In connection with the OWNER's right to stop work or suspend work, see Paragraphs 13.04 and 15.01. Paragraphs 15.02 and 15.03 deal with the OWNER's right to terminate services of the CONTRACTOR under certain circumstances.

GENERAL CONDITIONS

ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

9.01 OWNER'S REPRESENTATIVE

A. The ENGINEER will be the OWNER's representative during the construction period. The duties, responsibilities and the limitations of authority of the ENGINEER as the OWNER's representative during construction are set forth in a separate agreement with the OWNER and are summarized hereafter.

9.02 VISITS TO SITE

A. The ENGINEER will make visits to the site during construction to observe and inspect the progress and quality of the WORK and to determine, in general if the WORK is proceeding in accordance with the Contract Documents.

9.03 PROJECT REPRESENTATION

A. The ENGINEER will furnish a Project Representative to observe and inspect the performance of the WORK. The Project Representative and/or other authorized agents of the Engineer shall serve as the chief Owner/Engineer contact(s) with the Contractor during the construction phase. All submittals shall be delivered to and communications between the Engineer and the Contractor shall be handled by the Project Representative and/or other authorized agents. The Project Representative shall be the chief authorized representative of the Owner and the Engineer at the site of the work in all on-site relations with the Contractor.

9.04 CLARIFICATIONS AND INTERPRETATIONS

A. The ENGINEER will issue with reasonable promptness written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as the ENGINEER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

9.05 AUTHORIZED VARIATIONS IN WORK

A. The ENGINEER may authorize minor variation in the WORK as described in the Contact Documents when such variations do not involve an adjustment in the Contract Price or the Contract Time and are consistent with the overall intent of the Contract Documents. These variations shall be accomplished by issuing a Field Order. The issuance of a Field Order requires the CONTRACTOR to perform the work described in the order promptly. If the

CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Time and parties are unable to agree as the amount or extent thereof, the CONTRACTOR may make a claim therefor as provided in Article 11 or 12.

9.06 REJECTION OF DEFECTIVE WORK

A. The ENGINEER is authorized to reject work which the ENGINEER believes to be defective and require special inspection or testing of the WORK as provided in Paragraph 13.03G, whether or not the WORK is fabricated, installed, or completed.

9.07 CONTRACTOR SUBMITTALS, CHANGE ORDERS, AND PAYMENTS

A. The ENGINEER will review for approval all Contractor submittals, including shop drawings, samples, substitutes, and "or equal" items, etc., in accordance with the procedures set forth in the Technical Specifications.

B. In connection with the ENGINEER's responsibilities as to Change Orders, see Articles 10, 11, and 12.

C. In connection with the ENGINEER's responsibilities with respect to Applications for Payment, see Article 14.

9.08 DECISIONS ON DISPUTES

A. All claims, disputes, and other matters concerning the acceptability of the WORK, the interpretation of the requirements of the Contract Documents pertaining to the performance of the WORK, and claims for changes in the Contract Price or Contract Time under Articles 11 and 12 will be referred to the ENGINEER in writing with a request for formal decision in accordance with this paragraph. The ENGINEER will render a decision in writing within 30 days of receipt of the request. Written notice of each claim, dispute, or other matter will be delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 30 days) after the occurrence of the event. Written supporting data will be submitted to the ENGINEER with the written claim unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim.

B. When reviewing the claim or dispute, the ENGINEER will not show partiality to the OWNER or the CONTRACTOR and will incur no liability in connection with any interpretation or decision rendered in good faith. The ENGINEER's rendering of a decision with respect to any claim, dispute, or other matter (except any which have been waived by the making or acceptance of final

payment as provided in Paragraph 14.12) shall be a condition precedent to the OWNER's or the CONTRACTOR's exercise of their rights or remedies under the Contract Documents or by Law or Regulations with respect to the claim, dispute, or other matter.

9.09 LIMITATION ON ENGINEER'S RESPONSIBILITIES

A. Neither the ENGINEER's authority to act pursuant to its agreement with the OWNER, nor the description of that authority under this Article 9, nor any other description of the ENGINEER's responsibility in the Contract Documents, nor any decision made by the ENGINEER in good faith either to exercise or not exercise its authority, shall give rise to any duty or responsibility on the part of the ENGINEER to the CONTRACTOR, any Subcontractor, any Supplier, any surety or any other person or organization performing any part of the WORK.

B. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," as allowed," "as reviewed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," or "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review, or judgement of the ENGINEER as to the WORK, it is intended that such requirement, direction, review, or judgment will be solely to evaluate the WORK for compliance with the Contract Documents, unless there is a specific statement indicating otherwise. The use of any such term or adjective shall not be effective to assign to the ENGINEER any duty or authority to supervise or direct the performance of the WORK or any duty or authority to undertake responsibility contrary to the provisions of its agreement with the OWNER.

C. The ENGINEER will not be responsible for the CONTRACTOR's means, methods, techniques, sequences, or procedures of construction not specified in the Contact Documents or the safety precautions and programs incident thereto.

D. The ENGINEER will not be responsible for the acts or omissions of the CONTRACTOR nor of any subcontractor, supplier, or any other person or organization performing any of the WORK to the extent that such acts or omissions are not reasonably discoverable considering the level of observation and inspection required by the ENGINEER's agreement with the OWNER.

GENERAL CONDITIONS

ARTICLE 10 - CHANGES IN THE WORK

10.01 GENERAL

A. Without invalidating the Agreement and without notice to any surety, the OWNER may at any time or from time to time, order additions, deletions, or revisions in the WORK; these will be authorized by a written Field Order and/or a Change Order issued by the ENGINEER. Upon receipt of any of these documents, the CONTRACTOR shall promptly proceed with the work involved pursuant to the applicable conditions of the Contract Documents.

B. If the OWNER and the CONTRACTOR are unable to agree upon the increase or decrease in the Contract Price or an extension or shortening of the Contract Time, if any, that should be allowed as a result of a Field Order, a claim may be made therefor as provided in Articles 11 or 12.

C. The CONTRACTOR shall not be entitled to an increase in the Contract Price nor an extension of the Contract Time with respect to any work performed that is not required by the Contact Documents as amended, modified, or supplemented by Change Order, except in the case of an emergency and except in the case of uncovering work provided in the Paragraph 13.03G.

D. The OWNER and the CONTRACTOR shall execute appropriate Change Orders covering:

1. Changes in the WORK which are ordered by the OWNER pursuant to Paragraph 10.01A;

2. Changes required because of acceptance of defective work under Paragraph 13.06;

3. Changes in the Contract Price or Contact Time which are agreed to by the parties; or

4. Any other changes agreed to by the parties.

E. If the provisions of any Bond require notice of any change to be given to a surety, the giving of these notices will be the CONTRACTOR's responsibility. The CONTRACTOR shall provide for the amount of each applicable Bond to be adjusted accordingly.

10.02 ALLOWABLE QUANTITY VARIATIONS

A. Whenever a unit price and quantity have been established for a bid item in the Contract Documents, the quantity stated may be increased or decreased to a maximum of 25 percent with no change in the unit price. An adjustment in the quantity in excess of 25 percent will be sufficient to justify a change in the unit price. Changes in the quantity of all bid items established in the Contract Documents, regardless of whether the changes are more or less than 25 percent and at the unit price established in the Contract Documents or adjusted otherwise, shall be documented by Change Orders.

B. In the event a part of the WORK is to be entirely eliminated and no lump sum or unit price is named in the Contract Documents to cover the eliminated work, the price of the eliminated work shall be agreed upon in writing by the OWNER and the CONTRACTOR. If the OWNER and the CONTRACTOR fail to agree upon the price of the eliminated work, the price shall be determined in accordance with the provisions of Article 11.

GENERAL CONDITIONS

ARTICLE 11 - CHANGE OF CONTRACT PRICE

11.01 GENERAL

A. The Contact Price constitutes the total compensation payable to the CONTRACTOR for performing the WORK. Except as directed by Change Orders, all duties, responsibilities, and obligations assigned to or undertaken by the CONTRACTOR shall be at its expense without change in the Contract Price.

B. The Contract Price may only be changed by a Change Order. Any claim for an increase in the Contact Price shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 30 days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered with the claim, unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim, and shall be accompanied by the CONTRACTOR's written statement that the amount claimed covers all known amounts (direct, indirect, and consequential) to which the CONTRACTOR is entitled as a result of the occurrence of the event. If the OWNER and the CONTRACTOR cannot otherwise agree on the amount involved, all claims for adjustment in the Contract Price shall be determined by the ENGINEER in accordance with Paragraph 9.08A. No claim for an adjustment in the Contact Price will be valid if not submitted in accordance with this Paragraph 11.01B.

C. The value of any work covered by a Change Order or of any claim for an increase or decrease in the Contact Price shall be determined in one of the following ways:

1. Where the work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved.

2. By mutual acceptance of a lump sum, which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.

3. On the basis of the cost of work (determined as provided in Paragraphs 11.02 and 11.03) plus a CONTRACTOR's fee for overhead and profit (determined as provided in Paragraph 11.04).

11.02 COST OF WORK (BASED ON TIME AND MATERIALS)

A. General: The term "cost of work" means the sum of all costs necessarily incurred and paid by the CONTRACTOR for labor, materials, and equipment in the proper performance of work. Except as otherwise may be agreed to in writing by the OWNER, such costs shall be in amounts no higher than those prevailing in the locality of the Project.

B. Labor: The cost of labor used in performing work by the CONTRACTOR, a subcontractor, or other forces will be the sum of the following:

1. The actual wages paid plus any employer payments to, or on behalf of workers for fringe benefits including health and welfare, pension, vacation, and similar purposes. The cost of labor may include the rates paid to foremen when determined by the ENGINEER that the services of foremen do not constitute a part of the overhead allowance.

2. All payments imposed by state and federal laws including, but not limited to, compensation insurance, and social security payments.

3. The amount paid for subsistence and travel required by collective bargaining agreements, or in accordance with the regular practice of the employer.

At the beginning of the extra work and as later requested by the ENGINEER, the CONTRACTOR shall furnish the ENGINEER proof of labor compensation rates being paid.

C. Materials: The cost of materials used in performing work will be the cost to the purchaser, whether CONTRACTOR or subcontractor, from the supplier thereof, except as the following are applicable:

1. Trade discounts available to the purchase shall be credited to the OWNER notwithstanding the fact that such discounts may not have been taken by the CONTRACTOR.

2. For materials secured by other than a direct purchase and direct billing to the purchaser, the cost shall be deemed to be the price paid to the actual supplier as determined by the ENGINEER. Markup except for actual costs incurred in the handling of such materials will not be allowed.

3. Payment for materials from sources owned wholly or in part by the purchaser shall not exceed the price paid by the purchaser for similar materials from these sources on extra work items or current wholesale price for the materials delivered to the work site, whichever is lower.

4. If in the opinion of the ENGINEER the cost of material is excessive, or the CONTRACTOR does not furnish satisfactory evidence of the cost of the material, then the cost shall be deemed to be the lowest current wholesale price for the quantity concerned, delivered to the work site less trade discount. The OWNER reserves the right to furnish materials for the extra work and no claim shall be made by the CONTRACTOR for costs and profit on such materials.

D. Equipment: The CONTRACTOR will be paid for the use of equipment at the rental rate listed for the equipment specified in the Supplementary General Conditions. The rental rate will be used to compute payments for equipment whether the equipment is under the CONTRACTOR's control through direct ownership, leasing, renting, or another method of acquisition. The rental rate to be applied for use of each item of equipment shall be the rate resulting in the least total cost to the Owner for the total period of use. If it is deemed necessary by the CONTRACTOR to use equipment not listed in the Supplementary General Conditions an equitable rental rate for the equipment will be established by the ENGINEER. The CONTRACTOR may furnish cost data which might assist the ENGINEER in the establishing the rental rate.

1. All equipment shall, in the opinion of the ENGINEER, be in good working condition and suitable for the purpose for which the equipment is to be used.

2. Before construction equipment is used on the extra work, the CONTRACTOR shall plainly stencil or stamp an identifying number thereon at a conspicuous location, and shall furnish to the ENGINEER, in duplicate, a description of the equipment and its identifying number.

3. Unless otherwise specified, manufacturers' ratings and manufacturer approved modifications shall be used to classify equipment for the determination of applicable rental rates. Equipment which has no direct power unit shall be powered by a unit of at least the minimum rating recommended by the manufacturer.

4. Individual pieces of equipment or tools having a replacement value of $100 or less, whether or not consumed by use, shall be considered to be small tools and no payment will be made therefore.

5. Rental time will not be allowed while equipment is inoperative due to breakdowns.

E. Equipment on the Work: The rental time to be paid for equipment used on the WORK shall be the time the equipment is in productive operation on the extra work being performed and, in addition, shall include the time required to move the equipment to the location of the extra work and return it to the original location or to another location that requires no more moving time than that required to return it to its original location. Moving time will not be paid if the equipment is used on other than the extra work, even though located at the site of the extra work. Loading and transporting costs will be allowed, in lieu of moving time, when the equipment is moved by means other than its own power. However, no payment will be made for loading and transporting costs when the equipment is used on other than the extra work even though located at the site of the extra work. The following shall be used in computing the rental time of equipment on the WORK.

1. When hourly rates are listed, any part of an hour less than 30 minutes of operation shall be considered to be 1/2-hour of operation, and any part of an hour in excess of 30 minutes will be considered one hour of operation.

2. When daily rates are listed, any part of a day less than 4 hours operation shall be considered to be 1/2-day of operation. When owner-operated equipment is used to perform extra work to be paid for on a time and materials basis, the CONTRACTOR will be paid for the equipment and operator, as set forth in Paragraph (3), (4), and (5), following.

3. Payment for the equipment will be made in accordance with the provisions in Paragraph 11.02D, herein.

4. Payment for the cost of labor and subsistence or travel allowance will be made at the rates paid by the CONTRACTOR to other workers operating similar equipment already on the WORK, or in the absence of such labor, established by collective bargaining agreements for the type of workmen and location of the extra work, whether or not the operator is actually covered by such an agreement. A labor surcharge will be added to the cost of labor described herein in accordance with the provisions of Paragraph 11.02B, herein, which surcharge shall constitute full compensation for payments imposed by state and federal laws and all payments made to on behalf of workers other than actual wages.

5. To the direct cost of equipment rental and labor, computed as provided herein, will be added the allowances for equipment rental and labor as provided in Paragraph 11.04, herein.

11.03 SPECIAL SERVICES

A. Special work or services are defined as that work characterized by extraordinary complexity, sophistication, or innovation or a combination of the foregoing attributes which are unique to the construction industry. The following may be considered by the ENGINEER in making estimates for payment for special services:

1. When the ENGINEER and the CONTRACTOR, by agreement, determine that a special service or work is required which cannot be performed by the forces of the CONTRACTOR or those of any of its subcontractors, the special service or work may be performed by an entity especially skilled in the work to be performed. After validation of invoices and termination of market values by the ENGINEER, invoices for special services or work based upon the current fair market value thereof may be accepted without complete itemization of labor, material, and equipment rental cost.

2. When the CONTRACTOR is required to perform work necessitating special fabrication or machining process in a fabrication or a machine shop facility away from the job site, the charges for that portion of the work performed at the off-site facility may by agreement, be accepted as a special service and accordingly, the invoices from the work may be accepted without detailed itemization.

3. All invoices for special services will be adjusted by deducting all trade discounts offered or available, whether the discounts were taken or not. In lieu of the allowances for overhead and profit specified in Paragraph 11.04, herein, an allowance of 5 percent will be added to invoices for special services.

B. All work performed hereunder shall be subject to all of the provisions of the Contract Documents and the CONTRACTOR's sureties shall be bound with reference hereto as under the original Agreement. Copies of all amendments to surety bonds or supplemental surety bonds shall be submitted to the OWNER for review prior to the performance of any work hereunder.

11.04 CONTRACTOR'S FEE

A. WORK ordered on the basis of time and materials will be paid for at the actual necessary cost as determined by the ENGINEER, plus allowances for overhead and profit. For extra work involving a combination of increases and decreases in the WORK the actual necessary cost will be the arithmetic sum of the additive and deductive costs. The allowance for overhead and profit shall include full compensation for superintendence, bond and insurance premiums, taxes, office expenses, and all other items of expense or cost not included in the cost of labor, materials, or equipment provided for under Paragraphs 11.02B, C, and D, herein including extended overhead and home office overhead. The allowance for overhead and profit will be made in accordance with the following schedule:

ACTUAL NECESSARY COST OVERHEAD AND PROFIT ALLOWANCE

Labor ..... 10 percent

Materials ..... 10 percent

Equipment ..... 10 percent

B. It is understood that labor, materials, and equipment may be furnished by the CONTRACTOR or by the subcontractor, the allowance specified herein shall be applied to the labor, materials, and equipment costs of the subcontractor, to which the CONTRACTOR may add 5 percent of the subcontractor's total cost for the extra work. Regardless of the number of hierarchical tiers of subcontractors, the 5 percent increase above the subcontractor's total cost which includes the allowances for overhead and profit specified herein may be applied one time only for each separate work transaction.

GENERAL CONDITIONS

ARTICLE 12 - CHANGE OF CONTRACT TIME

12.01 GENERAL

A. The Contract Time may only be changed by a Change Order. Any claim for an extension of the Contract time shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 30 days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered within 30 days after such occurrence (unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the CONTRACTOR's written statement that the adjustment claimed is the entire adjustment to which the CONTRACTOR has reason to believe it is entitled as a result of the occurrence of said event. All claims for adjustment in the Contract Time shall be determined by the ENGINEER in accordance with Paragraph 9.08 if the OWNER and the CONTRACTOR cannot otherwise agree. No claim for an adjustment in the Contract Time will be valid if not submitted in accordance with the requirements of this Paragraph 12.01A.

B. The Contract Time will be extended in an amount equal to time lost if the CONTRACTOR makes a claim as provided in Paragraph 12.01A and the ENGINEER determines that the delay was caused by events beyond the control of the CONTRACTOR. Examples of events beyond the control of the CONTRACTOR include acts or neglect by the OWNER or others performing additional work as contemplated by Article 7, or by acts of God or of the public enemy, fire, floods, epidemics, quarantine restrictions, strikes, labor disputes, sabotage, or freight embargoes.

C. All time limits stated in the Contract Documents are of the essence.

D. None of the aforesaid time extensions shall entitle the CONTRACTOR to any adjustment in the Contract Price or any damages for delay. Furthermore, the CONTRACTOR hereby indemnifies and holds harmless the OWNER and ENGINEER, their officers, agents and employees from and against all claims, damages, losses and expenses (including lost property and attorney's fees) arising out of or resulting from the temporary suspension of work whether for the OWNER's convenience as defined in Article 15.01 (a) or for whatever other reasons including the stoppage of work by the ENGINEER for the CONTRACTOR's failure to comply with any order issued by the ENGINEER.

12.02 EXTENSIONS OF THE TIME FOR DELAY DUE TO INCLEMENT WEATHER

A. "Inclement weather" is any weather condition or conditions resulting immediately therefrom, causing the CONTRACTOR to suspend construction operations or preventing the CONTRACTOR from proceeding with at least 75 percent of the normal labor and equipment force engaged on the WORK.

B. Should the CONTRACTOR prepare to begin work at the regular starting time at the beginning of any regular work shift on any day on which inclement weather, or its effects on the condition of the WORK prevents work from beginning at the usual starting time and the crew is dismissed as a result thereof, the CONTRACTOR will not be charged for a working day whether or not conditions change thereafter during the day and the major portion of the day could be considered to be suitable for construction operations.

C. The CONTRACTOR shall base its construction schedule upon the inclusion of the number of days of inclement weather specified in the paragraph entitled "Inclement weather delays" of the Supplementary General Conditions. No extension of the Contract Time due to inclement weather will be considered until after the stated number of days of inclement weather has been reached. However, no reduction in Contract Time will be made if the number of inclement weather days is not reached.

12.03 EXTENSIONS OF TIME FOR OTHER DELAYS

A. If the CONTRACTOR is delayed in completion of the WORK beyond the time named in the Contract Documents for the completion of the WORK, by acts of God or of the public enemy, fire, floods, epidemics, quarantine restrictions, strikes, labor disputes, industry-wide shortage of raw materials, sabotage or freight embargoes, the CONTRACTOR shall be entitled to an adjustment in the Contract Time. No such adjustment will be made unless the CONTRACTOR shall notify the ENGINEER in writing of the causes of delay within 15 calendar days from the beginning of any such delay. The ENGINEER shall ascertain the facts and the extent of the delay. No adjustment in time shall be made for delays resulting from noncompliance with the Contract, accidents, failure on the part of the CONTRACTOR to carry out the provisions of the Contract including failure to provide materials, equipment or workmanship meeting the requirements of the Contract Documents; the occurrence of such events shall not relieve the CONTRACTOR from the necessity of maintaining the required progress.

B. In the event that Contract completion is delayed beyond the Contract Time named in the Specifications by reason of shortages of raw materials required for CONTRACTOR-furnished items, the CONTRACTOR shall be entitled to

an adjustment in the Contract Time in like manner as if the WORK had been suspended for the convenience and benefit of the OWNER; provided, however, that the CONTRACTOR shall furnish documentation acceptable to the OWNER and ENGINEER that he placed or attempted to place firm orders with suppliers at a reasonable time in advance of the required date of delivery of the items in question, that such shortages shall have developed following the date such orders were placed or attempts made to place same, that said shortages are general throughout the affected industry, that said shortages are shortages of raw materials required to manufacture CONTRACTOR-furnished items and not simply failure of CONTRACTOR's suppliers to manufacture, assemble or ship items on time, and that the CONTRACTOR shall, to the degree possible, have made revisions in the sequence of his operations, within the terms of the Contract, to offset the expected delay. The CONTRACTOR shall notify the ENGINEER, in writing, concerning the cause of delay, within 15 calendar days of the beginning of such delay. The validity of any claim by the CONTRACTOR to an adjustment in the Contract Time shall be determined by the OWNER acting through the ENGINEER, and his findings thereon shall be based on the ENGINEER's knowledge and observations of the events involved and documentation submitted by the CONTRACTOR, showing all applicable facts relative to the foregoing provisions. Only the physical shortage of raw materials will be considered under these provisions as a cause for adjustment of time and no consideration will be given to any claim that items could not be obtained at a reasonable, practical, or economical cost or price, unless it is shown to the satisfaction of the OWNER that such items could have been obtained only at exorbitant prices entirely out of line with current rates taking into account the quantities involved and the usual practices in obtaining such quantities.

C. If the CONTRACTOR is delayed in completion of the WORK by reason of changes made under the provisions of Article 10 or changed conditions as provided under Article 4.03, or by failure of the OWNER to acquire or clear right-of-way as provided under Article 15.01, or by any act of the ENGINEER or of the OWNER, not contemplated by the Contract, an adjustment in the Contract time will be made by the OWNER in like manner as if the WORK had been suspended for the convenience and benefit of the OWNER, except, that if the WORK is increased as a result of changes, the OWNER, at his sole discretion, may grant an adjustment in the number of calendar days for completion of the Contract. In the event of such delay, the CONTRACTOR shall notify the ENGINEER in writing of the causes of delay within 15 calendar days from the beginning of any such delay.

GENERAL CONDITIONS

ARTICLE 13 - WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

13.01 WARRANTY, GUARANTEE AND MAINTENANCE PERIOD

A. The CONTRACTOR warrants and guarantees to the OWNER and the ENGINEER that all work, equipment, materials and workmanship are in accordance with the Contract Documents and are not defective. Prompt notice of defects discovered by the OWNER or ENGINEER shall be given to the CONTRACTOR. All defective work, whether or not in place, may be rejected, corrected, or accepted as provided in this Article 13.

B. If within one (1) year after the date of Final Completion, as set by the Engineer's Notice of Completion, or a longer period of time prescribed by Laws or Regulations or by the terms of any applicable special guarantee or specific provisions of the Contract Documents, any work is found to be defective, the OWNER shall notify the CONTRACTOR in writing and the CONTRACTOR shall promptly, without cost to the OWNER and in accordance with the OWNER's written notification, either correct the defective work, or, if it has been rejected by the OWNER, remove it from the site and replace it with non-defective work. In the event the CONTRACTOR does not promptly comply with the notification, or in an emergency where delay would cause serious risk of loss or damage, the OWNER may have the defective work corrected or rejected work removed and replaced. All direct, indirect, and consequential costs of the removal and replacement including but not limited to fees and charges of engineers, architects, attorneys and other professionals will be paid by the CONTRACTOR. This paragraph shall not be construed to limit nor diminish the CONTRACTOR's absolute guarantee to complete the WORK in accordance with the Contract Documents.

13.02 ACCESS TO WORK

A. The ENGINEER, other representatives of the OWNER, testing agencies, and governmental agencies with jurisdictional interests shall have access to the work at reasonable times for their observation, inspections, and testing. The CONTRACTOR shall provide proper and safe conditions for their access.

13.03 TESTS AND INSPECTIONS

A. The CONTRACTOR shall give the ENGINEER timely notice of readiness of the WORK for all required inspections, tests, or approvals.

B. If Laws or Regulations of any public body other than the OWNER, with jurisdiction over the WORK require any work to be specifically inspected, tested, or approved, the CONTRACTOR shall pay all costs in connection therewith. The CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with the OWNER's or the ENGINEER's acceptance of a Supplier of materials or equipment proposed as a substitution or-equal to be incorporated in the WORK and of materials or equipment submitted for review prior to the CONTRACTOR's purchase for incorporation in the WORK. The cost of all inspections, tests, and approvals with the exception of the above which are required by the Contract Documents shall be paid by the OWNER (unless otherwise specified).

C. The ENGINEER will make, or have made, such inspections and test as the ENGINEER deems necessary to see that the WORK is being accomplished in accordance with the requirements of the Contract Documents. The Contractor without additional cost to the OWNER, shall provide the labor and equipment necessary to make the WORK available for inspections. Unless otherwise specified in the Supplementary General Conditions or the OWNER-ENGINEER Agreement, all other costs of inspection and testing will be borne by the OWNER. In the event the inspections or tests reveal non-compliance with the requirements of the Contract Documents, the CONTRACTOR shall bear the cost of corrective measures deemed necessary by the ENGINEER, as well as the cost of subsequent re-inspection and retesting. Neither observations by the ENGINEER nor inspections, tests, or approvals by others shall relieve the CONTRACTOR from the CONTRACTOR's obligation to perform the WORK in accordance with the Contract Documents.

D. All inspections, tests, or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by properly licensed organizations selected by the OWNER.

E. If any work (including the work of others) that is to be inspected, tested, or approved is covered without the ENGINEER's written authorization, it must, if requested by the ENGINEER, be uncovered for testing, inspection, and observation. The uncovering shall be at the CONTRACTOR's expense unless the CONTRACTOR timely notified the ENGINEER of the CONTRACTOR's intention to cover the same and the ENGINEER failed to act with reasonable promptness in response to the notice.

F. In any work is covered contrary to the written request of the ENGINEER, it must, if requested by the ENGINEER, be uncovered for the ENGINEER's observation and replaced at the CONTRACTOR's expense.

G. If the ENGINEER considers it necessary or advisable that covered work be observed, inspected or tested by the ENGINEER or others, the ENGINEER shall direct the CONTRACTOR to uncover, expose, or otherwise make available for observation, inspection, or testing that portion of the work in question. The CONTRACTOR shall comply with the ENGINEER's direction and furnish all necessary labor, material, and equipment. If found the work is defective, the CONTRACTOR shall bear all direct, indirect and consequential costs of uncovering, exposure, observation, inspection, and testing and of satisfactory reconstruction of the work, including but not limited to fees and charges for engineers, architects, attorneys, and other professionals. However, if the work is not defective, the CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Time, or both. The increase in Contract Time and Contract Price shall be the CONTRACTOR's actual time and costs directly attributable to uncovering and exposing the work. If the parties are unable to agree as to the amount or extent of the changes, the CONTRACTOR may make a claim therefor as provided in Articles 11 and 12.

13.04 OWNER MAY STOP THE WORK

A. If the WORK is defective, or the CONTRACTOR fails to perform work in such a way that the completed WORK will conform to the Contract Documents, the OWNER may order the CONTRACTOR to stop the WORK, or any portion thereof, until the cause for the order has been eliminated. This right of the OWNER to stop the WORK shall not give rise to any duty on the part of the OWNER to exercise this right for the benefit of the CONTRACTOR or any other party.

13.05 CORRECTION OR REMOVAL OF DEFECTIVE WORK

A. When directed by the ENGINEER, the CONTRACTOR shall promptly correct all defective work, whether or not fabricated, installed, or completed, or, if the

work has been rejected by the ENGINEER, remove it from the site and replace it with non-defective work. The CONTRACTOR shall bear all direct, indirect and consequential costs of correction or removal, including but not limited to fees and charges of engineers, architects, attorneys, and other professionals made necessary thereby.

13.06 ACCEPTANCE OF DEFECTIVE WORK

A. If, instead of requiring correction or removal and replacement of defective work, the OWNER prefers to accept the work, the OWNER may do so. The CONTRACTOR shall bear all direct, indirect, and consequential costs attributable to the OWNER's evaluation of and determination to accept the defective work. If any acceptance of defective work occurs prior to final payment, a Change Order will be issued incorporating the necessary revisions in the Contact Documents with respect to the WORK, and the OWNER shall be entitled to an appropriate decrease in the Contract Price.

GENERAL CONDITIONS

ARTICLE 14 - PAYMENTS TO CONTRACTOR, LIQUIDATED DAMAGES AND COMPLETION

14.01 SCHEDULE OF VALUES (LUMP SUM PRICE BREAKDOWN)

A. The schedule of values or lump sum price breakdown established as provided in the Technical Specifications shall serve as the basis for progress payments and will be incorporated into the form of Application for Payment included in the Contract Documents.

14.02 UNIT PRICE BID SCHEDULE

A. Progress payments for unit price work will be based on the number of units completed.

14.03 APPLICATION FOR PROGRESS PAYMENT

A. Unless otherwise prescribed by the Owner, on the 25th of each month, the CONTRACTOR shall submit to the ENGINEER for review and approval, an Application for Payment completed and signed by the CONTRACTOR covering the WORK completed as of the date of the Application and accompanied by such supporting documentation as required by the Contract Documents.

B. The Application for Payment shall identify, as a sub-total, the amount of the CONTRACTOR's Total Earnings to Date, plus the Value of Materials at the Site which have not yet been incorporated in the WORK, and less a deductive adjustment for materials installed which were not previously incorporated in the WORK, but for which payment was allowed under the provisions of payment for Materials Stored at the Site but not yet incorporated in the WORK.

C. The Net Payment Due to the CONTRACTOR shall be the above-mentioned sub-total, from which shall be deducted the retainage amount and the total amount of all previous payments made to the CONTRACTOR.

D. The OWNER may withhold and retain 5% of each approved progress payment to the CONTRACTOR. The total retention proceeds withheld shall not exceed 5% of the total construction price. All retention proceeds shall be placed by the OWNER in an interest-bearing account. The interest accrued shall be for the benefit of the CONTRACTOR and its subcontractors, and it shall be paid after the WORK has been completed and accepted by the OWNER. CONTRACTOR shall ensure that any interest accrued on the

retainage is distributed by the CONTRACTOR to its subcontractors on a pro rata basis.

E. Any retention proceeds withheld, and any accrued interest, shall be released by the OWNER pursuant to an Application for Payment from the CONTRACTOR within 45 days from the later of:

1. the date the OWNER receives the final Application for Payment from the CONTRACTOR;

2. the date that a certificate of occupancy or final acceptance notice is issued to:

   (a) the Contractor who obtained the building permit from the building inspector or from a public agency;

   (b) the OWNER; or

   (c) the ENGINEER.

3. the date the CONTRACTOR accepts final payment for the Work; or

4. the date that a public agency or building inspector having authority to issue its own certificate of occupancy does not issue the certificate but permits partial or complete occupancy of a newly constructed or remodeled building; provided, however, that if only partial occupancy of a building is permitted, any retention proceeds withheld and retained, and any accrued interest, shall be partially released in direct proportion to the value of the part of the building occupied.

Each Application for Payment from the CONTRACTOR shall include documentation of lien releases or waivers.

F. Notwithstanding any other provision in this Article to the contrary,

1. If the CONTRACTOR is in default or breach of the terms and conditions of the Contract Documents, the OWNER may withhold from payment to the CONTRACTOR for so long as reasonably necessary an amount necessary to cure the breach or default of the CONTRACTOR; or

2. If the WORK or a portion of the WORK has been substantially completed, the OWNER may retain until completion up to twice the

fair market value of the WORK of the CONTRACTOR that has not been completed:

(a) in accordance with the Contract Documents; or

(b) in the absence of applicable provisions in the Contract Documents to generally accepted craft standards.

3. If the OWNER refuses payment under subparagraphs (F)(i) or (ii), it shall describe in writing within 45 days of withholding such amounts what portion of the WORK was not completed according to the standards specified in the Contract Documents.

G. The CONTRACTOR shall distribute retention proceeds as outlined below:

1. Except as provided in Paragraph 14.03.G.2, below, if the CONTRACTOR receives retention proceeds, it shall pay each of its subcontractors from whom retention has been withheld each subcontractor's share of the retention received within ten days from the day that all or any portion of the retention proceeds is received from the OWNER.

2. Notwithstanding Paragraph 14.03.G.1, above, if a retention payment received by the CONTRACTOR is specifically designated for a particular subcontractor, payment of the retention shall be made to the designated subcontractor.

H. Except as otherwise provided in the Supplementary General Conditions, the value of materials stored at the site shall be valued at 95 percent of the value of the materials. This amount shall be based upon the value of all acceptable materials and equipment stored at the site or at another location agreed to in writing by the OWNER; provided, each individual item has a value of more than $5,000 and will become a permanent part of the WORK. The Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that the CONTRACTOR has received the materials and equipment free and clear of all liens, charges, security interests, and encumbrances (which are hereinafter in these General Conditions referred to as "Liens") and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect the OWNER's interest therein, all of which will be satisfactory to the OWNER.

14.04 CONTRACTOR'S WARRANTY OF TITLE

A. The CONTRACTOR warrants and guarantees that title to all work, materials, and equipment covered by an Application for Payment, whether incorporated in the WORK or not, will pass to the OWNER no later than the time of final payment free and clear of all liens.

14.05 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

A. The ENGINEER will, within 7 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to the OWNER, or return the Application to the CONTRACTOR indicating in writing the ENGINEER's reasons for refusing to recommend payment. In the later case, the CONTRACTOR may make the necessary corrections and resubmit the Application. Thirty days after presentation of the Application for Payment with the ENGINEER's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.05B) become due and when due will be paid by the OWNER to the CONTRACTOR.

B. The OWNER may refuse to make payment of the full amount recommended by the ENGINEER to compensate for claims made by the OWNER on account of the CONTRACTOR's performance of the WORK or other items entitling the OWNER to a credit against the amount recommended, but the OWNER must give the CONTRACTOR written notice within 7 days (with a copy to the ENGINEER) stating the reasons for such action.

14.06 PARTIAL UTILIZATION

A. The OWNER may utilize or place into service any item of equipment or other usable portion of the WORK at any time prior to completion of the WORK. The OWNER shall notify the CONTRACTOR in writing of its intent to exercise this right. The notice will identify the equipment or specific portion or portions of the WORK to be utilized or otherwise placed into service.

B. It shall be understood by the CONTRACTOR that until such written notification is issued, all responsibility for care and maintenance of all items or portions of the WORK to be partially utilized shall be borne by the CONTRACTOR. Upon the issuance of a notice of partial utilization, the ENGINEER will deliver to the OWNER and the CONTRACTOR a written recommendation as to division of responsibilities between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance,

heat, utilities and insurance. Upon the OWNER's acceptance of these recommendations, the ENGINEER's aforesaid recommendation will be binding on the OWNER and the CONTRACTOR until final payment.

C. The CONTRACTOR shall retain full responsibility for satisfactory completion of the WORK, regardless of whether a portion thereof has been partially utilized by the OWNER and the CONTRACTOR's one year correction period shall commence only after the date of Final Completion for the WORK.

14.07 LIQUIDATED DAMAGES

A. The CONTRACTOR shall pay to the OWNER the amount specified in the Supplemental General Conditions, not as a penalty but as liquidated damages, if he fails to complete the WORK or specified parts of the WORK within the time or times agreed upon. The periods for which these damages shall be paid shall be the number of Days from the agreed date or Contract Time as contained in the Agreement, or from the date of termination of any extension of time approved by the OWNER, to the date or dates on which the ENGINEER certifies Substantial Completion of WORK or specified parts of the WORK as provided in Article 14.08, herein. The OWNER may deduct the amount of said damages from any monies due or to become due the CONTRACTOR. After Substantial Completion, if the CONTRACTOR fails to complete the remaining WORK within 45 days or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER the amount stated in the Supplemental General Conditions as liquidated damages for each day that expires after the 45 days until readiness for final payment.

B. The said amount is fixed and agreed upon by and between the CONTRACTOR and the OWNER because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the OWNER would sustain; and said amount is agreed to be the amount of damages which the OWNER would sustain. Said damages are not in lieu of but in addition to other actual or consequential damages to which the OWNER may be entitled.

C. All times specified in the Contract Documents are hereby declared to be of the essence.

14.08 SUBSTANTIAL COMPLETION

A. When the CONTRACTOR considers the WORK ready for its intended use, and the CONTRACTOR has delivered to the ENGINEER all maintenance and operating instructions, schedules, guarantees, bonds, certificates of

inspection, marked-up record documents and other documents, all as required by the Contract Documents, the CONTRACTOR may notify the OWNER and the ENGINEER in writing that the WORK is substantially complete and request that the ENGINEER prepare a Certificate of Substantial Completion. Within a reasonable time thereafter, the OWNER, the CONTRACTOR, and the ENGINEER shall make an inspection of the WORK to determine the status of completion. If the ENGINEER does not consider the WORK substantially complete, the ENGINEER will notify the OWNER and CONTRACTOR in writing giving the reasons therefor. If the ENGINEER considers the WORK substantially complete, the ENGINEER will prepare and deliver to the OWNER for its execution the Certificate of Substantial Completion signed by the ENGINEER and CONTRACTOR, which shall fix the date of Substantial Completion.

B. The Certificate of Substantial Completion shall be a release by the CONTRACTOR of the OWNER and its agents from all claims and liability to the CONTRACTOR for anything done or furnished for, or relating to, the WORK or for any act or neglect of the OWNER or of any person relating to or affecting the WORK, to the date of Substantial Completion, except demands against the OWNER for the remainder of the amounts kept or retained from progress payments and excepting pending, unresolved claims filed in writing prior to the date of Substantial Completion. At the time of delivery of the Certificate of Substantial Completion, the ENGINEER will deliver to the OWNER and the CONTRACTOR, if applicable, a written recommendation as to division of responsibilities between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities and insurance. Upon the OWNER's acceptance of these recommendations, the ENGINEER's recommendation will be binding on the OWNER and the CONTRACTOR until final payment.

C. The OWNER, upon written notice to the CONTRACTOR, shall have the right to exclude the CONTRACTOR from the WORK after the date of Substantial Completion, and complete all or portions of the WORK at the CONTRACTOR's expense.

14.09 COMPLETION AND FINAL PAYMENT

A. Upon written certification from the CONTRACTOR that the WORK is complete (if a Certificate of Substantial Completion has been issued this certification must occur within 45 days of that date), the ENGINEER will make a final inspection with the OWNER and the CONTRACTOR. If the OWNER and ENGINEER do not consider the WORK complete, the ENGINEER will notify the OWNER and the CONTRACTOR in writing of all particulars in which this inspection reveals that the WORK is incomplete or defective. The CONTRACTOR shall immediately take the measures necessary to remedy these deficiencies. If the ENGINEER and OWNER consider the WORK complete, the CONTRACTOR may proceed to file its application for final payment pursuant to this Article. At the request of the CONTRACTOR, the ENGINEER may recommend to the OWNER that certain minor deficiencies in the WORK that do not prevent the entire WORK from being used by the OWNER for its intended use, and the completion of which will be unavoidably delayed due to no fault of the CONTRACTOR, be exempted from being completed prerequisite to final payment. These outstanding items of pickup work, or "punch list items", shall be listed on the ENGINEER's Notice of Completion, together with the recommended time limits for their completion, and extended warranty requirements for those items and the value of such items.

B. After the issuance of the Notice of Completion and after the CONTRACTOR has completed corrections that have not been exempted to the satisfaction of the ENGINEER and delivered to the ENGINEER all required additions and modifications to maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, marked-up record documents and other documents, all as required by the Contract Documents; and after the ENGINEER has indicated that the WORK is acceptable, the CONTRACTOR may make application for final payment following the procedure for progress payments. The final application for payment shall be accompanied by all documentation called for in the Contract Documents and other data and schedules as the OWNER or ENGINEER may reasonably require, including an affidavit of the CONTRACTOR that all labor, services, material, equipment and other indebtedness connected with the WORK for which the OWNER or his property might in any way be responsible, have been paid or otherwise satisfied, and a consent of the payment bond surety to final payment, all in forms approved by the OWNER.

14.10 FINAL APPLICATION FOR PAYMENT

A. If, on the basis of the ENGINEER's observation of the WORK during construction and final inspection, and the ENGINEER's review of the final application for payment and accompanying documentation, all as required by the Contract Documents, the ENGINEER is satisfied that the WORK has been completed and the CONTRACTOR has fulfilled all of his obligations under the Contract Documents, the ENGINEER will, within ten days after receipt of the final application for payment, indicate in writing his recommendation of payment and present the application to the OWNER for payment. Thereupon, the ENGINEER will give written notice to the OWNER and the CONTRACTOR that the WORK is acceptable by executing the ENGINEER's Notice of Completion. Otherwise, the ENGINEER will return the application to the CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case the CONTRACTOR shall make the necessary corrections and resubmit the application.

B. Within 45 calendar days after the ENGINEER's filing of the Notice of Completion, the OWNER will make final payment including all deducted retainage (except as noted below) to the CONTRACTOR. The OWNER's remittance of final payment shall be the OWNER's acceptance of the WORK if formal acceptance of the WORK is not indicated otherwise. The final payment shall be that amount remaining after deducting all prior payments and all amounts to be kept or retained under the provisions of the Contract, including the following items:

1. Liquidated damages, as applicable.

2. All amounts retained by the OWNER under Paragraph 14.03(F).

14.11 CONTRACTOR'S CONTINUING OBLIGATIONS

A. The CONTRACTOR's obligation to perform and complete the WORK in accordance with the Contract Documents shall be absolute. Neither recommendation of any progress or final payment by the ENGINEER, nor the issuance of a Certificate of Substantial Completion or Notice of Completion, nor payment by the OWNER to the CONTRACTOR under the Contract Documents, nor any use or occupancy of the WORK or any part thereof by the OWNER, nor any act of acceptance by the OWNER nor any failure to do so, nor any review of a shop drawing or sample submittal, will constitute an acceptance of work or materials not in accordance with the Contract Documents or a release of the CONTRACTOR's obligation to perform the WORK in accordance with the Contract Documents.

14.12 FINAL PAYMENT TERMINATES LIABILITY OF OWNER

A. Final payment is defined as the last progress payment made to the CONTRACTOR for earned funds, less deductions listed in Paragraph 14.10B herein. The acceptance by the CONTRACTOR of the final payment referred to in Paragraph 14.10 herein, shall be a release of the OWNER and its agents from all claims of liability to the CONTRACTOR for anything done or furnished for, or relating to, the work or for any act or neglect of the OWNER or of any person relating to or affecting the work, except demands against the OWNER for the remainder, if any, of the amounts kept or retained under the provisions of Paragraph 14.10 herein; and excepting pending, unresolved claims filed prior to the date of the Certificate of Substantial Completion.

GENERAL CONDITIONS

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

15.01 SUSPENSION OF WORK BY OWNER

A. The OWNER acting through the ENGINEER may, by written notice to the Contractor, temporarily suspend the WORK, in whole or in part, for a period or periods of time, but not to exceed 90 days, for the convenience and benefit of the OWNER upon the occurrence of any one or more of the following: (1) unsuitable weather; (2) delay in delivery of OWNER- furnished equipment or materials, or such other conditions as are considered unfavorable for prosecution of the work; (3) Shortfall in construction funds; (4) Constraints imposed by public entities, public utilities, property owners or legal proceedings; (5) Failure or delay in acquisition of easements or right-of-way by the OWNER; or (6) Other conditions which, in the opinion of the OWNER, warrant a delay in the WORK. Suspended WORK shall be resumed by the CONTRACTOR within 10 calendar days of receipt from the ENGINEER of written notice to proceed. Whenever the OWNER temporarily suspends work for any conditions enumerated in this Article 15.01 A, the CONTRACTOR shall be entitled to an adjustment in the Contract Time as specified in Article 12.03 C.

B. The suspension of work shall be effective upon receipt by the Contractor of the written order suspending the work and shall be terminated upon receipt by the Contractor of the written order terminating the suspension.

C. The CONTRACTOR hereby indemnifies and holds harmless the OWNER and ENGINEER, their officers, agents and employees, from and against all claims, damages, losses and expenses, including lost profits and attorney's fees, arising out of or resulting from the temporary suspension of the WORK, whether for the OWNER's convenience described in this Article or for whatever other reasons, including the stoppage of work by the ENGINEER for the CONTRACTOR's failure to comply with any order issued by the ENGINEER.

15.02 TERMINATION OF AGREEMENT BY OWNER (CONTRACTOR DEFAULT)

A. In the event of default by the CONTRACTOR, the OWNER may give written notice to the CONTRACTOR of OWNER's intent to terminate the Agreement. The notice shall state the event of default and the time allowed to remedy the default. It shall be considered a default by the CONTRACTOR whenever the CONTRACTOR shall: (1) declare bankruptcy, become insolvent, or assign its assets for the benefit of its creditors; (2) fail to provide materials or workmanship meeting the requirements of the Contract Documents; (3) disregard or violate provisions of the Contract Documents or ENGINEER's

instructions, (4) fail to prosecute the WORK according to the approved progress schedule; or, (5) fail to provide a qualified superintendent, competent workmen, or materials or equipment meeting the requirements of the Contract Documents. If the CONTRACTOR fails to remedy the conditions constituting default within the time allowed, the OWNER may then issue a Notice of Termination.

B. In the event the Agreement is terminated in accordance with Paragraph 15.02A, the OWNER may take possession of the WORK and may complete the WORK by whatever method or means the OWNER may select. The cost of completing the WORK shall be deducted from the balance which would have been due the CONTRACTOR had the Agreement not been terminated and the WORK completed in accordance with the Contract Documents. If such cost exceeds the balance which would have been due, the CONTRACTOR shall pay the excess amount to the OWNER. If such cost is less than the balance which would have been due, the CONTRACTOR shall have no claim to the difference.

15.03 TERMINATION OF AGREEMENT BY OWNER (FOR CONVENIENCE)

A. The OWNER may terminate the Agreement at any time if it is found that reasons beyond the control of either the OWNER or CONTRACTOR make it impossible or against the OWNER's interests to complete the WORK. In such a case, the CONTRACTOR shall have no claims against the OWNER except: (1) for the value of the work, as determined by the engineer, performed by the Contractor up to the date the Agreement is terminated; and, (2) for the cost of materials and equipment on hand, in transit, or on definite commitment, as of the date the Agreement is terminated, which would be needed in the WORK and which meet the requirements of the Contact Documents. The value of work performed and the cost of materials and equipment delivered to the site, as mentioned above, shall be determined by the ENGINEER in accordance with the procedure prescribed from making the final application for payment and final payment under Paragraphs 14.09 and 14.10.

15.04 TERMINATION OF AGREEMENT BY CONTRACTOR

A. The CONTRACTOR may terminate the Agreement upon 10 days written notice to the OWNER, whenever: (1) the WORK has been suspended under the provisions of Paragraph 15.01, for more than 90 consecutive days through no fault or negligence of the CONTRACTOR, and notice to resume work or to terminate the agreement has not been received from the OWNER within this time period; or, (2) the OWNER should fail to pay the

CONTRACTOR any monies due him in accordance with the terms or the Contract Documents and within 60 days after presentation to the OWNER by the CONTRACTOR of a request therefor, unless within said 10-day period the OWNER shall have remedied the condition upon which the payment delay was based. In the event of such termination, the CONTRACTOR shall have no claims against the OWNER except for those claims specifically enumerated in Paragraph 15.03, and as determined in Accordance with the requirements of that paragraph.

GENERAL CONDITIONS

ARTICLE 16 - MISCELLANEOUS

16.01 GIVING NOTICE

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

16.02 TITLE TO MATERIALS FOUND ON THE WORK

A. The OWNER reserves the right to retain title to all soils, stone, sand, gravel, and other materials developed and obtained from excavations and other operations connected with the WORK. Unless otherwise specified in the Contract Documents, neither the CONTRACTOR nor any subcontractor shall have any right, title, or interest in or to any such materials. The CONTRACTOR will be permitted to use in the WORK, without charge, any such materials which meet the requirements of the Contract Documents.

16.03 RIGHT TO AUDIT

A. If the CONTRACTOR submits a claim to the OWNER for additional compensation, the OWNER shall have the right, as a condition to considering the claim, and as a basis for evaluation of the claim, and until the claim has been settled, to audit the CONTRACTOR's books. This right shall include the right to examine books, records, documents, and other evidence and accounting procedures and practices, sufficient to discover and verify all direct and indirect costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The right to audit shall include the right to inspect the CONTRACTOR's plants, or such parts thereof, as may be or have been engaged in the performance of the WORK. The CONTRACTOR further agrees that the right to audit encompasses all subcontracts and is binding upon subcontractors. The right to examine and inspect herein provided for shall be exercisable through such representatives as the OWNER deems desirable during the CONTRACTOR's normal business hours at the office of the CONTRACTOR. The CONTRACTOR shall make available to the OWNER for auditing, all relevant accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the OWNER.

16.04 ASBESTOS

A. If the CONTRACTOR during the course of work observes the existence of asbestos in any structure or building, the CONTRACTOR shall promptly notify the OWNER and the ENGINEER. The OWNER shall consult with the ENGINEER regarding removal or encapsulation of the asbestos material and the CONTRACTOR shall not perform any work pertinent to the asbestos material prior to receipt or special instruction from the OWNER through the ENGINEER.

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 17- GENERAL

17.01 GENERAL

1. These Supplemental General Conditions amend or supplement the General Conditions of the Contract and any other provisions of the Contract Documents as indicated herein. All provisions which are not so amended or supplemented remain in full force and effect.

2. The terms used in these Supplemental General Conditions which are defined in the General Conditions of the Contract have the meanings assigned to them in the General Conditions of the Contract herein.

17.02 SUPPLEMENTAL DEFINITIONS

1. ENGINEER

The "Engineer" is Heath Engineering
377 West 800 North
Salt Lake City, Utah 84103
(801)322-0487
heath@heatheng.com

17.03 TESTING COSTS

1. Paragraph 13.03 of the General Conditions is amended as follows: the

CONTRACTOR shall pay all testing costs. The Owner reserves the right to have additional tests performed by a testing organization selected by the OWNER and at the OWNER’s expense.

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 18 - AMOUNTS OF LIQUIDATED DAMAGES, BONDS AND INSURANCE

18.01 AMOUNT OF LIQUIDATED DAMAGES

A. As provided in Article 14.07 of the General Conditions, the Contractor shall pay to the Owner as liquidated damages the amount of $1,000 for each calendar day's delay beyond the Contract Time for substantial completion. The Contractor shall pay to the Owner as liquidated damages the amount of $200 for each calendar day's delay beyond 45 calendar days from the date of substantial Completion until the Engineer issues the Notice of Final Completion.

18.02 PERFORMANCE AND OTHER BOND AMOUNTS

A. The CONTRACTOR shall furnish a satisfactory Performance Bond in the amount of 100 percent of the Contract Price and a satisfactory Payment Bond in the amount of 100 percent of the Contract Price.

18.03 INSURANCE AMOUNTS

The limits of liability for the insurance required by Paragraph 5.02 of the General Conditions shall provide for not less than the following amounts or greater where required by Laws and Regulations:

A. Workers' Compensation under Paragraph 5.02B.1 of the General Conditions:

1. State: Utah — Statutory

B. Comprehensive General Liability: (under Paragraph 5.02B.2 of the General Conditions):

1. Bodily Injury (including completed operations and products liability):

$ 500,000 — Each Occurrence
$ 1,000,000 — Annual Aggregate

Property Damage:

$ 500,000 — Each Occurrence
$ 1,000,000 — Annual Aggregate
or a combined single limit of — $1,000,000

2. Property Damage liability insurance including, Explosion, Collapse and Underground coverages, where applicable.

3. Personal Injury, with employment exclusion deleted

$ 1,000,000 Annual Aggregate

C. Comprehensive Automobile Liability: (Under Paragraph 5.02B.3 of the General Conditions:)

1. Bodily Injury

$ 500,000 Each Person
$ 1,000,000 Each Occurrence

2. Property Damage:

$ 500,000 Each Occurrence

or combined single limit of $1,000,000

D. Builders Risk: Not required.

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 19 - PHYSICAL CONDITIONS AND WEATHER DELAYS

19.01 INCLEMENT WEATHER DELAYS

A. The Contractor's construction schedule shall be based upon the inclusion of at least five (5) day(s) of inclement weather delays. Reference Article 12, paragraph 12.02 of the General Conditions for additional requirements.

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 20 - SUBCONTRACT LIMITATIONS

20.01 SUBCONTRACT LIMITATIONS

A. In addition to the provisions of Paragraph 6.05 of the General Conditions, the CONTRACTOR shall perform not less than 20 percent of the WORK with its own forces (i.e., without subcontracting). The 20 percent requirement shall be understood to refer to the WORK, the value of which totals not less than 20 percent of the Contract Price.

ARTICLE 21 - MISCELLANEOUS

21.01 PATENTS AND COPYRIGHTS

The Contractor shall indemnify and save harmless the Owner, the Engineer, and their officers, agents, and employees, against all claims or liability arising from the use of any patented or copyrighted design, device, material, or process by the Contractor or any of his subcontractors in the performance of the work.

TECHNICAL SPECIFICATIONS

DIVISION 22
PLUMBING

SECTION 220000 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

Sections of other Divisions which relate to plumbing work apply to the work of this section. See various Sections on site work, underfloor work, structural work, finish materials, etc.

1.2 SUMMARY: This Section specifies the basic requirements for plumbing installations and includes requirements common to more than one section of Division 220000. It expands and supplements the requirements of Division 01000.

This Division does not define, nor is it limited by, trade jurisdictions. All work described herein is a part of the General Contract and is required of the Contractor regardless.

1.3 DESCRIPTION OF PROJECT: The plumbing work described in these plumbing specifications is for a project located in West Jordan, Utah. Design weather conditions are: 96° db, 62° wb, and winter 1°F. Altitude readings, unless otherwise noted, are for an elevation of 4,500 feet above sea level. Make adjustment to manufacturer's performance data as needed.

1.4 CODES AND PERMITS, AUTHORITIES HAVING JURISDICTION:

A. The plumbing work shall be performed in strict accordance with the applicable provisions of the various codes, ordinances and adoptions pertaining to the project location in effect on the date of invitation for bids. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

B. The Contractor shall hold and save the Owner and Architect/Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

C. Permits necessary for the prosecution of the work under this contract shall be secured and paid for by the contractor(s).

D. REFERENCE STANDARDS:

American Welding Society
International Mechanical Code 2021 with Utah State Amendments
International Building Code 2021 with Utah State Amendments
International Plumbing Code 2021 with Utah State Amendments
International Fuel Gas Code 2021 with Utah State Amendments
NFPA Codes
Local Fuel Utility Regulations
Local Power Utility Regulations
American Gas Association
ASME Codes for Pressure Vessels and Piping
ANSI B31.1 Piping
ANSI A117.1 Buildings and Facilities Accessible To and Usable by Physically Handicapped People.
ADA: Americans with Disability Act

E. Final inspection by the Architect/Engineer will not be made nor Certificate of Substantial Completion issued until certificates of acceptability from the Authorities having jurisdiction are delivered.

1.5 DEFINITION OF PLANS AND SPECIFICATIONS: The plumbing drawings show the general arrangement of piping, equipment, etc., and shall be followed as closely as the actual building construction and the work of other trades will permit. Request clarification and participate in resolution in the event of conflict.

Because of the small scale of the plumbing drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such extensions, fittings, valves and accessories to meet the conditions as may be required. Some small scale work is not shown such as control conduit and piping, incidental piping, specialties. Provide as directed by note or specification.

Examine the actual construction site prior to bidding and obtain an understanding of the conditions under which the work will be performed. No allowances will be made for failure to make such examination.

During construction, verify the dimensions governing the plumbing work at the building. No extra compensation shall be claimed nor allowed because of differences between actual dimensions and those indicated on the drawings. Examine adjoining work on which plumbing work is dependent for perfect efficiency, and report any work of other trades which must be corrected. No waiver of responsibility for defective work shall be claimed nor allowed due to failure to report unfavorable conditions affecting the plumbing work.

1.6 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 50 for rough-in requirements.

1.7 PLUMBING INSTALLATIONS:

A. Coordinate plumbing equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for plumbing installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

F. Coordinate the cutting and patching of building components to accommodate installation of plumbing equipment and materials.

G. Where mounting heights are not detailed or dimensioned, install plumbing services and overhead equipment to provide the maximum headroom possible.

H. Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

I. Coordinate the installation of plumbing materials and equipment above ceilings with suspension system, ductwork, plumbing equipment, light fixtures, and other installations.

J. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

K. Where plumbing work penetrates other trade work such as gypsum board walls, etc., penetration shall be neatly cut and walls shall be filled and patched.

1.8 ACCESSIBILITY:

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Establish required clearance to all installation features involving operation and maintenance. Respect manufacturer’s recommendations for access and clearance.

D. Access Doors - General: All items of plumbing equipment which may require adjustment, maintenance, replacement or which control a system function shall be made readily accessible to personnel operating the building.

1. Provide access doors in floors, walls, ceiling and partitions to valves, cleanouts, chases, etc. Access doors shall be all-steel construction equivalent to "Milcor" by Inland Ryerson in a style approved by the Owner's Representative. Doors shall be 24" x 24", or as needed, with screwdriver latches.

1.9 CHANGE ORDERS: See General Conditions.

1.10 ALTERNATIVE CONSTRUCTION/SUBSTITUTION: These documents outline a way in which the Owner may be delivered a functional and reliable facility. Drawings and specifications describe reasonable engineering practice for the Contractor to follow.

Coordination between trades may result in periodic needs to adjust the installation from that indicated, but in no case shall the intended function be compromised.

The Contractor may perceive some work methods which differ from those specified which could save time and effort. These may be presented to the Architect with a breakdown of possible cost savings for review. Implement only with authorization.

Materials substitutions will generally be covered in a review process prior to bidding. After bidding, substitutions shall be proposed only on the basis of definitive cost accounting and implemented only with authorization.

1.11 CUTTING AND PATCHING:

A. Layout the project ahead of time, providing sleeves and blockouts and have work specifically formed, poured and framed to accommodate plumbing installations. Cut and patch only as needed.

B. Refer to the Division 1 Section: CUTTING AND PATCHING for general requirements for cutting and patching.

C. RECORD DRAWINGS: During the course of construction, maintain a set of drawings, specifications, change orders, shop drawings, addenda, etc., for reference and upon which all deviations from the original layout are recorded. These marked-up documents shall be turned over to the Architect/Engineer at the conclusion of the work so that the original tracings can be revised. If the Contractor fails to mark up the prints, he shall reimburse the Architect/Engineer for time required to do so.

D. Refer Specification Section: BASIC ELECTRICAL REQUIREMENTS for cutting and patching electrical equipment, components, and materials.

E. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

F. Arrange for repairs required to restore other and any work damaged as a result of plumbing installations.

G. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

H. Perform cutting, fitting, and patching of plumbing equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;

2. Remove and replace defective Work;

3. Remove and replace Work not conforming to requirements of the Contract Documents;

4. Remove samples of installed Work as specified for testing:

5. Install equipment and materials in existing structures.

I. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

J. Cut, remove and legally dispose of selected plumbing equipment, components, and materials as indicated, including, but not limited to removal of plumbing piping and other plumbing items made obsolete by the new Work.

K. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

L. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1.12 SUBMITTALS: Submittal of shop drawings, product data, and samples will be accepted only from the Contractor to the Architect. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed. The Contractor shall document each transmittal and shall sign and stamp the submittal indicating that it has been reviewed and is in compliance with the criteria of the project, any exceptions being clearly noted.

A. SHOP DRAWINGS: As soon as possible after the contract is awarded, submit to the Architect, an electronic copy of the descriptive literature covering all equipment and materials to be used in the installation of plumbing systems for this project. Written confirmation of acceptable review by the Owner's Representative shall be obtained before ordering, purchasing, acquiring or installing any such equipment or materials for the project.

The submittals shall be prepared in an orderly manner after the order of this specification, contained in a single PDF format file with summary pages for each item or group of related items. Submitted literature shall clearly indicate performance, quality, utility requirements, dimensions of size, connection points and other information pertinent to effective review.

Equipment must fit into the available space with allowance for operation, maintenance, etc. The Contractor shall take full responsibility for space and utility requirements for equipment installed.

Factory-wired equipment shall include shop drawings of all internal wiring to be furnished with unit.

Review of the Architect/Engineer is for general conformance of the submitted equipment of the project specification; in no way does such approval relieve Contractor of his obligation to furnish equipment and materials that comply in detail to the specification, nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions which may affect his work.

1.13 GUARANTEE/WARRANTY: The following guarantee is a part of this specification and shall be binding on the part of the Contractor and his assigns:

"Contractor guarantees that this installation is in accordance with the terms of the Contract and is free from mechanical defects. He agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance. See also the General Conditions of these specifications. Failed equipment in the repair or replacement shall be guaranteed for one full year from the date of recommission."

Compile and assemble the warranties required by Division 15 into a separated set of vinyl covered, insert sheets, tabulated and indexed for each reference, included in the O & M Manual.

Provide complete warranty information for each item to include product or equipment to include data of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

Plumbing systems and equipment shall not be considered for substantial completion and initiation of warranty until they have performed in service continuously without malfunction for at least thirty (30) working days.

1.14 TESTS AND CERTIFICATIONS: Make all tests required by code or specification in the presence of a representative of the Owner, recorded and certified by the Contractor and Representative. Involve local authorities where required.

1.15 PERMITS, FEES, LICENSES: Pay for all permits, fees and licenses required for the conduct of the specified work and be responsible for all criteria associated with the same. Comply with requirements for inspection, certifications, etc.

1.16 CEILING SPACE COORDINATION: Carefully coordinate ceiling cavity space with all trades; however, installation of plumbing equipment within the ceiling cavity space allocation, in the ev

ent of conflict, shall be in the following order: plumbing waste lines; supply, return and exhaust ductwork; domestic hot and cold water; fire protection; control conduit.

PART 2 - GENERAL PLUMBING MATERIALS AND METHODS

2.1 QUALITY OF MATERIALS AND EQUIPMENT:

A. All equipment and materials shall be new, and shall be the standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment, and shall be the manufacturer's latest design. Specific equipment shown in schedules on drawings and specified herein is to be the basis for the Contractor's bid. Provisions for substitute equipment are outlined in the General Conditions. All materials shall be produced by manufacturing plants located in the United States of America.

B. Furnish and install all major items of equipment specified in the equipment schedules on the drawings complete with all accessories normally supplied with catalog items listed, and all other accessories necessary for a complete and satisfactory installation.

2.2 PROTECTION OF MATERIALS AND EQUIPMENT:

A. Close pipe and duct openings with caps or plugs to prevent lodgement of dirt or trash during the course of installation. Cover equipment tightly and protect against dirt, water and chemical or mechanical injury. Plumbing fixtures intended for the final installation shall not be used by the construction forces. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly and deliver in a factory dock condition for the Owner's acceptance. Make damage and defects developing before acceptance of the work good at Contractor's expense.

B. Do not make temporary use of project equipment during construction without the consent of the Owner.

2.3 QUALIFICATIONS OF WORKMEN:

A. All mechanics shall be capable journeymen, skilled in the work assigned to them. Apprentices may be used with appropriate direction.

B. Employ no unskilled persons in the work which he is given to do; execute all work in a skillful and workmanlike manner. All persons employed upon this work shall be competent, faithful, orderly and satisfactory to the Owner. Should the Owner's Representative deem anyone employed on the work incompetent or unfit for his duties, and so certify, Contractor shall dismiss him and he shall not be again employed upon the work without permission of the Owner's Representative.

C. All welders involved in welding of pressure piping systems shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Written verification of successful test completion shall be submitted to Architect prior to initiating work.

2.4 FOREMAN: Designate a general plumbing foreman to the Owner's Representative to be co

nsistently available on site for consultation. Do not replace this individual without prior approval from the Owner's Representative.

2.5 USE OF COMMON VENDORS: Regardless of subcontract delegations, coordinate purchasing between trades so that equipment and materials of similar nature come from a single vendor, i.e., all package HVAC units shall be common source. Valves, etc., the same. Do not burden the Owner with multiple brands of similar equipment unless so directed.

2.6 ROOF/WALL/FLOOR PENETRATIONS - FLASHINGS:

A. Sleeves through the floor into dry rooms shall be flush with the floor, caulked and sealed.

B. Pipe sleeves shall allow for movement of the pipe due to expansion and contraction, yet to include seismic restraint.

C. Refer to Section for fire stopping requirements.

D. FLASHINGS:

1. Flash all pipes and ducts penetrating the roof. Vent pipes terminating within 24" of the roof shall have a seamless flashing of 6-pound lead clamped to the pipe, and with a flashing shield extended horizontally not less than 12" all around. For single ply membrane roof, follow manufacturer's directions, provide required flashing components.

2. For built-up and gravel roof, clamp roof drains to a 6-pound lead flashing extending 18" all around. For single ply membrane roof, follow manufacturer's directions.

3. Other piping penetrating the roof shall be flashed and counterflashed. See drawings or Architect/Engineer for additional detail.

4. Make all ductwork penetrating the roof watertight with flashings, counterflashing and sealant. Provide curbs for all such openings.

2.7 EXCAVATING AND BACKFILLING (GENERAL):

A. Provide all excavation, trenching and backfilling for Division 22 00 00 underground piping work. Excavation and backfilling shall comply with applicable paragraphs of Division 2. Tamp bottoms of trenches hard and, for soil and waste piping, grade to secure uniform fall of 1/4" per foot, or as noted. Excavate bell holes for hub and spigot pipes so that pipe rests on solid ground for its entire length. Lay sewer and water pipe in separate trenches, except where otherwise noted, as detailed.

B. After work has been tested, inspected and approved by the Owner's Representative and/or State/Local Inspector, and prior to backfilling, clean the excavation of all rubbish, and clean backfill materials free of trash. Backfill shall be placed in horizontal layers not exceeding 12" in thickness, properly moistened. Mechanically compact each layer with suitable equipment to a dry density of not less than 95 percent as determined by the Modified AASHO Test T-18O. See Division 2 for additional requirements.

1. Provide adequate shoring to safeguard workers from cave-ins for all excavations.

2. In areas where General Contractor has finish grade work to do, Plumbing Contractor shall backfill and compact to 8" below finish grade. Where no finish surface work is to be done, Plumbing Contractor shall backfill and compact to and match adjacent undisturbed surface with allowance for settling, etc.

3. Protect from damage all existing underground utilities or utility tunnels indicated on the contract drawings (or field located for the Contractor by the Owner prior to excavation operations). Any damage to identified existing utilities or utility tunnels shall be repaired by the Contractor at no cost to the Owner.

2.8 HANGERS AND SUPPORTS (GENERAL):

A. Provide hangers and/or supports for all equipment, piping and ductwork. Primary information is contained in these specifications and on the drawings.

B. Provide hangers and supports to correlate with seismic restraint and vibration isolation.

2.9 MANUFACTURER'S DIRECTIONS: Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the plans and specifications, report such conflicts to the Architect, who shall direct adjustments as he deems necessary and desirable.

2.10 LUBRICATION: Lubricate equipment at startup. Then, provide all lubricants for the operation of all equipment until acceptance by the Owner. The Contractor is held responsible for all damage to bearings while the equipment is being operated by him.

2.11 FLUSHING AND DRAINING OF SYSTEMS/CLEANING OF PIPING: Fill, clean and flush and sterilize where appropriate, all water piping systems with water and drain these systems before they are placed in operation. Blow out all other piping systems with compressed air or nitrogen to remove foreign materials that may have been left or deposited in the piping system during its erection.

2.12 ARCHITECTURAL ACCESS DOORS:

A. Extent of Work: Provide architectural grade access doors at each point of required access to piping valves, and specialties, concealed equipment, etc. Coordinate this work with other sections for ceilings, walls, etc.

B. Material: Steel framed doors with heavy duty hinges and latch type locking mechanisms with surface finish configuration to accept, match or correlate with adjacent surface.

Product equivalent to Inland-Ryerson “Milcor”.

C. Installation: Complete, blended into adjacent work.

2.13 JOBSITE CLEANUP:

A. Keep site clean during progress of work.

B. At the conclusion of work, clean all installation thoroughly.

1. Leave equipment in a factory dock condition. Correct any damage and touch up or repaint if necessary.

2. Remove all debris from site.

END OF SECTION 220000

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-22 Plumbing section, and is part of each Division-22 section making reference to valves specified herein.

1.2 SUMMARY:

A. Extent of valves required by this section is indicated on drawings and/or specified in other Division-22 sections.

B. Types of valves specified in section include the following:

1. Drain Valves.
2. Ball Valves.

C. Valves furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. VALVE TYPES: Provide valves of same type by same manufacturer.

C. VALVE IDENTIFICATION: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing Manufacturer's figure number, size, location, and valve features for each required valve.

B. SHOP DRAWINGS: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. MAINTENANCE DATA: Submit maintenance data and spare parts lists for each type of valve. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division 1.

1.5 REFERENCES:

A. CODES AND STANDARDS:

1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".
3. UL and FM Compliance: Provide valves used in fire protection piping, which are UL-listed and FM approved.

PART II - PRODUCTS

2.1 VALVES:

A. GENERAL: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

B. SIZES: Unless otherwise indicated, provide valves of same size as upstream pipe size.

C. OPERATORS: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, 5" and smaller, other than plug valves. Provide one wrench for every 10 plug valves. Provide gear operators for quarter-turn valves 6" and larger. Provide chain-operated sheaves and chains for overhead valves 4" and larger over 8'-0" AFF.

D. CONNECTIONS: Unless otherwise noted for a particular reason, any valve 2" and larger shall have flanges.

2.2 MANUFACTURERS: Unless listed otherwise subject to compliance with requirements, provide valves of one of the manufacturers listed for each type of valve. All valves of the same type shall be of the same manufacturer.

2.3 DOMESTIC COLD WATER, DOMESTIC HOT WATER, DOMESTIC HOT WATER RETURN (COPPER PIPE):

A. BALL VALVES:

1. Domestic water piping 3” and smaller: 400 psig WOG @ 250ºF bronze construction, threaded or solder ends, bubble tight mineral filled. PTFE seat at 250 psig under water, low lead compliant. Operate with flow in either direction. Lever or tee handle as required. Suitable for tight shut-off. Domestic manufactured only.

2. Uses: Isolation valves for domestic water and gas services. Drain valves shall be furnished with a capped ¾" threaded hose outlet connection with chain on cap connected to valve body.

3. Approved Manufacturers:

   a. Apollo 70-140 or 70-240
   b. Milwaukee BA-100S or BA-150S
   c. Hammond UP8313A and UP8303A
   d. Nibco T/S-585-70-66.
   e. Watts

B. SWING CHECK VALVES:

1. 2" and Smaller: Crane No. 37 bronze, threaded, Y-pattern, 200# WOG at swing check valve.
2. 2-1/2" and Larger: Crane No. 373, iron body, flanged, 200# WOG swing check valve with bronze trim.

C. BALANCING VALVES: Bell and Gossett circuit setter plus or Armstrong CB circuit balancing valve with pressure taps or Flowset. Gate valves, Ball valves or butterfly valves may not be used as balancing valves. Provide schedule showing pressure drop and flow rate of each valve.

PART III - INSTALLATION

3.1 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

B. Install valves with stems on horizontal or above.

C. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

D. All branch lines which supply a specific area of the building (such as a toilet room or kitchen) shall be valved near the main so that each area may be isolated from the system for repairs without having to shut down both men and women's restrooms, other labs, or the whole building.

E. All valves located above a non-lay-in type ceiling or behind a wall shall be made accessible by means of an access door.

END OF SECTION 220523

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-22 Plumbing sections apply to work of this section.

1.2 SCOPE OF WORK:

A. All plumbing piping and equipment (excluding thermostats and relays), and distribution systems shall be labeled. Electrical switches and starters for plumbing equipment shall also be labeled.

PART II - GENERAL PLUMBING MATERIALS AND METHODS

2.1 EQUIPMENT, VALVE AND PIPE IDENTIFICATION:

A. Items to be labeled shall include all items of plumbing equipment including pumps, and electrical switches and starters for plumbing equipment and gages.

B. Information to be put on label shall include the following:

1. Identification number and name. This number and name shall generally be the same as that shown on the plans or in these specifications.

2. Where the item is a pump, the flow and head shall be indicated and the system served.

3. If part of a unit, it shall have, in addition to its own number, the number of the main item it is serving.

4. Valves shall be tagged as to the area served and have their normal operating position indicated.

5. Where it is apparent which main unit a valve is serving, only the function of the valve need be included on the nameplate.

6. Type of nameplates shall be as follows:

a. Valve tags shall be aluminum embossed 3/4" tags with identification on one side for valves. Tags for magnetic starters shall be glued to the metal starter cover. Tags shall be as manufactured by Addressograph Company and shall be Addressograph No. B-5300.

b. Equipment nameplates shall be black face formica with white engraved lettering 3/16" high or larger.

7. Methods of attaching labels shall be as follows:

a. Valve tags to be connected to valve stem by steel rings or chains.

b. Screws for equipment labels.

8. Example of typical nameplate series:

a. Pump nameplate for above unit:

1) “DCW PUMP NO. 1
2) SERVES BLDG HOT WATER
3) 3 GPM - 15 FT.”

b. Switch nameplate for above pump:

1) “DISCONNECT - DCP 1"

c. Sample nameplate for valve where it is apparent what valve is serving:

1) “DOM. COLD WATER TO ROOMS 120 - N.O.”

9. NOTE: Above are samples and do not necessarily apply to actual conditions. Room numbers shall be as assigned by Owner to actual conditions.

C. Identification of Piping:

1. All piping shall be painted under general painting section of this specification and be identified under this section in accordance with the following:

2. Means of Identification: All piping systems shall be identified according to one of the following schemes:

a. MECHANICAL/FAN ROOM SYSTEMS AND EXPOSED SYSTEMS:

1) Identifying Legend
2) Flow Direction Arrow

b. CONCEALED SYSTEMS:

1) Identifying Legend
2) Flow Direction Arrow

3. In concealed space, identify at the following interval:

a. Every 50 feet interval along continuous runs.
b. At least once in every room if less than 50 feet
c. At each riser or junction.
d. Above or behind ceiling or wall access doors.

4. Colors: The following colors shall be used in accordance with the pipe identification code hereinafter specified.

a. Color Coding as follows:

Material	Color	Identifying Legend	Lettering
Domestic Cold	Green	Cold Water	Black
Domestic Hot	Green	Hot Water	Black
Domestic Hot Return	Lime	Hot Water Return	Black
Roof Drain	Black	Drain Water	White
Waste	Black	Waste Water	White
Gas	Yellow	Natural Gas	Black

5. Identifying Legends: Legends shall be painted or stenciled on pipe over background color in such a location on the pipe as to be readily visible to operating personnel from the floor. Legends must be painted on in black or white as indicated. Self-adhesive or glue-on type labels will not be acceptable.

a. Letters for identifying legends shall be 2" high for 3" and larger pipe, 1" for 1-1/4" to 2-1/2" pipe and 1/2" for 1" pipe and smaller.

6. Flow Direction Arrows: Arrows to indicate direction of flow inside the pipe shall be painted over the background color in black or white, the same color as the identifying legend and point away from it.

a. The “shaft” of the arrow shall be 2" long and shall be 1" in width on pipes 3" in diameter or more and 1/2" in width on pipes 2-1/2" in diameter or less. The “head” of the arrow shall be formed by an equilateral triangle having a base equal to twice the width of the “shaft”.

b. Use double-headed arrow if flow can be in both directions, such as expansion lines.

c. Identify direction in mechanical rooms not in exposed public ways at walls and every 20 feet.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections apply to work of this section.

B. Division-22 Section 220000 - Plumbing applies to work of this section.

1.2 SUMMARY:

A. Extent of plumbing insulation required by this section is indicated on drawings and schedules as required by the current Model Energy Code, and by requirements of this section. Use no asbestos in this work.

B. Types of plumbing insulation specified in this section include the following:

1. Piping Systems Insulation:

a. Fiberglass.

C. Refer to Division-22 section "Hangers and Supports for Plumbing Piping and Equipment" for protection saddles, protection shields, and thermal hanger shields.

D. Refer to Division-22 section "Identification for Plumbing Piping and Equipment" for installation of identification devices for piping and equipment.

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. INSTALLER'S QUALIFICATIONS: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

C. FLAME/SMOKE RATINGS: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each plumbing system

requiring insulation.

B. MAINTENANCE DATA: Submit maintenance data and replacement material lists for each type of plumbing insulation. Include this data and product data in maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Deliver insulation, coverings, cements, adhesives and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard ratings of products.

B. Protect insulation against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART II - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. MANUFACTURER: Subject to compliance with requirements, provide plumbing insulation materials of one of the following (except as noted):

1. Armstrong World Industries, Inc.
2. Babcock and Wilcox Co., Insulating Products Div.
3. CertainTeed Corp.
4. Knauf Fiber Glass GmbH.
5. Manville Products Corp.
6. Owens-Corning Fiberglass Corp.
7. Pittsburgh Corning Corp.
8. Rubatex Corp.
9. Thermacell
10. IMOCA

2.2 PIPING INSULATION MATERIALS:

A. PREFORMED FIBERGLASS PIPING INSULATION: ASTM C 547. (Class 1 for use to 450^{o}F (230^{o}C); Class 2 for use to 650^{o}F (345^{o}C); Class 3 for use to 1200^{o}F (650^{o}C).

B. JACKETS FOR PIPING INSULATION: All purpose (ASJ) fire retardant jacket, ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

C. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.

D. Encase exterior fittings insulation and piping with aluminum jacket with weather-proof construction.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 PIPING SEALANT THROUGH WALLS: See also Division 23 Section.

A. Sealant shall be a two-part foamed silicone elastomer equal to Dow Corning 3-6548 Silicone RTV foam. Sealant shall be applied at any piping or duct penetration through fire or smoke walls to prevent air from passing through the opening.

B. Sealant cell structure, foamed in place, shall be U.L. classified and shall meet the smoke development and fuel contribution ratings specified. Sealant shall be stable at extreme temperatures, and shall effectively confine such hazards as fire, smoke and gases.

C. Sealant required at any fire/smoke wall penetration to be according to approved detail for each specific wall assembly. Contractor shall submit detail for engineer approval.

2.4 FIRE/SMOKE ENCASEMENT:

A. Any and all PVC, PVDF, polypropylene, acid waste and vent and any other plastic piping located in return air plenums shall be encased in rated flame and smoke system. The encasement shall be equal to Firemaster “Plastic Pipe Fire Protection System.” The enclosure shall meet all codes.

PART III - EXECUTION

3.1 GENERAL:

A. Piping insulation shall be fiberglass one-piece performed pipe insulation with all purpose (ASJ) fire retardant jacket.

B. Fittings and valves shall be insulated and covered with Zeston covers.

C. All cold water, roof drains, secondary roof drains or any other lines upon which condensate moisture could form, shall have a vapor-proof jacket.

D. Fire and smoke hazard for a complete insulation system shall not exceed:

1. Flame spread - 25
2. Fuel contribution - 50
3. Smoke development - 50

E. Insulation protection shields equal to Grinnell Figure 167 shall be installed on all insulated pipe 1" and larger. Hangers shall not contact pipe where pipe is specified to be insulated.

3.2 INSPECTION:

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.3 PLUMBING PIPING SYSTEM INSULATION:

A. INSULATION OMITTED: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions strainers check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, fire protection piping, and pre-insulated equipment.

B. COLD PIPING:

Application Requirements: Insulate the following cold plumbing piping systems:

1. Potable cold water piping
2. Roof drain bodies
3. Interior above-ground storm water piping, including roof drain, deck drain and secondary roof and deck drain piping.
4. Plumbing vents within 6 lineal feet of roof or wall outlet.

Insulate each piping system specified above with one of the following types and thicknesses of insulation:

1. Fiberglass with all service jacket, self sealing lap:
1/2" thick for pipe sizes up to and including 3/4"; 1" thick for pipe sizes over 3/4".

C. HOT PIPING:

Application Requirements: Insulate the following hot plumbing piping systems:

1. Potable hot water piping.
2. Potable hot water recirculating piping.
3. Hot drain piping (where indicated).

Insulate each piping system specified above with one of the following types and thicknesses of insulation:

1. Fiberglass with all service jacket, self-sealing lap K factor of .24 to .28 at 100^{o} mean rating temperature; 1" thick for pipe sizes up to and including 1-1/4"; 1-1/2" thick for pipe sizes over 1-1/4".

3.4 INSTALLATION OF PIPING INSULATION:

A. GENERAL: Install insulation products in accordance with the manufacturer's written

instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

3.5 PROTECTION AND REPLACEMENT:

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. PROTECTION: Insulation Installer shall advise Contractor of required protection for insulation work during construction period to avoid damage and deterioration.

END OF SECTION 220700

SECTION 221000 - GENERAL PIPES AND FITTINGS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-22 Basic Mechanical Materials and Methods section, and is part of each Division-22 section making reference to pipes and pipe fittings specified herein.

1.2 SUMMARY:

A. This section is generic in that it describes material and installation required by several other sections of this specification.

B. Types of pipes and pipe fittings specified in this section include the following:

1. Steel Piping
2. Copper Piping
3. Cast-Iron Pressure Piping
4. Cast-Iron Soil Piping
5. Miscellaneous Piping Materials/Products.

C. Pipes and pipe fittings furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-15 sections.

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. INSTALLER'S QUALIFICATIONS:

1. Firm with at least three years history of successful experience on projects of similar nature.

2. Licensed as a firm in the contractor state of origin and in the State of Utah.

3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the contractor.

4. All workmen employed on the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

C. WELDING CERTIFICATION:

1. Each welder shall have passed a qualification test within the past six months of starting work on the project.

2. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.

3. The test report shall certify that the welder is qualified to weld the material to be used at the job site.

4. Submit three copies of each welder's qualification test report to the Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

B. WELDING CERTIFICATIONS: Submit reports as required for piping work.

C. BRAZING CERTIFICATIONS: Submit reports as required for piping work.

D. MAINTENANCE DATA: Submit maintenance data and parts lists for each type of mechanical fitting. Include this data, product data, and certifications in maintenance manual; in accordance with requirements of Division 1.

1.5 REFERENCES:

A. CODES AND STANDARDS:

1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.

2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

3. NSF Labels: Where plastic piping is indicated to transport potable water, provide pipes and pipe fittings bearing approval label by National Sanitation Foundation (NSF).

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Except for concrete, corrugated metal, hub-and-spigot, clay, and similar units of pipe, provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART II - PRODUCTS

2.1 GENERAL:

A. PIPING MATERIALS: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards. Use United States (domestic) manufactured pipe only. Do not use foreign made pipe.

B. PIPE/TUBE FITTINGS: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable. Use domestic manufactured fittings only. Do not use foreign manufactured fittings.

2.2 COPPER TUBE AND FITTINGS:

A. COPPER TUBE: ASTM B 88; Type K, L (wall thickness) as indicated for each service; hard-drawn temper, except as otherwise indicated.

B. DWV COPPER TUBE: ASTM B 306.

C. ACR COPPER TUBE: ASTM B 280.

D. CAST-COPPER SOLDER-JOINT FITTINGS: ANSI B16.18.

E. WROUGHT-COPPER SOLDER-JOINT FITTINGS: ANSI B16.22.

F. CAST-COPPER SOLDER-JOINT DRAINAGE FITTINGS: ANSI B16.23.

G. WROUGHT-COPPER SOLDER-JOINT DRAINAGE FITTINGS: ANSI B16.29.

H. CAST-COPPER FLARED TUBE FITTINGS: ANSI B16.26.

I. BRONZE PIPE FLANGES/FITTINGS: ANSI B16.24.

J. COPPER-TUBE UNIONS: Provide standard products recommended by manufacturer for use in service indicated.

2.3 CAST-IRON SOIL PIPES AND PIPE FITTINGS:

A. HUBLESS CAST-IRON SOIL PIPE: FS WW-P-401.

B. CAST-IRON HUB-AND-SPIGOT SOIL PIPE: ASTM A 74.

C. HUBLESS CAST-IRON SOIL PIPE FITTINGS: Neoprene gasket complying with ASTM C 564 and stainless steel clamp holding band.

D. CAST-IRON HUB-AND-SPIGOT SOIL PIPE FITTINGS: Match soil pipe units; complying with same standards (ASTM A 74).

E. COMPRESSION GASKETS: ASTM C 564.

F. LEAD/OAKUM JOINT MATERIALS: Provide products complying with governing regulations for use in service indicated.

2.4 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

A. WELDING MATERIALS: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.

Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. SOLDERING MATERIALS: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements. Use no lead bearing solders in domestic water applications.
Tin-Antimony Solder: ASTM B 32, Grade 95TA.

Silver-Lead Solder: ASTM B 32, Grade 96TS.

C. BRAZING MATERIALS: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.

Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

D. GASKETS FOR FLANGED JOINTS: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

E. PIPING CONNECTORS FOR DISSIMILAR NON-PRESSURE PIPE: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

MANUFACTURER: Subject to compliance with requirements, provide piping connectors of the following:

1. Fernco, Inc.

2.5 STRAINERS:

A. Y pattern, self cleaning, line size. Armstrong, Bailey, Crane, Fisher, Mueller, Sarco, Strong, or Yarway.

Iron Body, Screwed Ends 2" and Smaller: 250 psig at 425°F, screen mesh to suit service.

Flanged Iron Body 2-1/2" and Larger: 125 psig steam pressure rating, screen mesh to suit service.

B. Basket pattern, quick release lid. Mueller #155 to 30 psi, Mueller #165 to 125 psi.

2.6 FLOOR, WALL AND CEILING PLATES (ESCUTCHEONS): Where exposed pipes pass through floors, finished walls or finished ceilings, they shall be fitted with chromium plated cast brass flanges with set screws. Plates shall be large enough to completely close the hole around the pipe, and shall be not less than 1-1/2" nor more than 2-1/2" larger than the diameter of the pipes or insulation. All plates shall be securely held in place.

2.7 PROTECTIVE COATINGS: All underground steel pipes shall be wrapped with Scotchwrap No. 50 tape to give not less than two complete layers on the underground piping system, or piping shall have "X-tru Coat", factory applied plastic protective covering, or pipe shall be coated and wrapped with coal tar enamel and Kraft paper, all with coated and taped joints.

2.8 DIELECTRIC/INSULATING FITTINGS: Insulating fittings shall be used to connect dissimilar metals (such as steel and copper) to prevent electrolytic action. Insulating fittings are not required between bronze valves and steel pipe or between copper coil headers and steel pipe.

2.9 FLEXIBLE CONNECTIONS: At pumps and at all rotating or vibrating pieces of equipment, provide flexible connectors to accommodate alignment and vibration. A general appropriate connector is Hyspan Series 4500 flexible metal with corrugated stainless steel inner core and braided wrap. Flexible connections shall be full line size. A series of three Victaulic couplings may be used for water service.

PART III - EXECUTION

3.1 INSTALLATION:

A. GENERAL: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently- leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible union, flanges, etc., for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Do not cold spring. Store filler weld materials in accordance with codes.

Comply with ANSI B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated. Provide high point vents, low point drains with valves and extension to drain for all piping.

C. All piping in mechanical rooms, fan rooms, etc., shall be exposed. Do not conceal or imbed piping in walls, floors or other structures.

D. Make changes in direction or size with manufactured fittings. Anchor and support piping for free expansion and movement without damage to piping, equipment or to building.

E. Piping shall be arranged to maintain head room and keep passageways clear.

F. Provide unions at connections to equipment and elsewhere as required to facilitate maintenance.

G. Run full pipe size through shutoff valves, gas cocks, balancing valves, etc. Change pipe size within three pipe size diameters of final connection to equipment, coils, etc.

H. All piping shall be erected to insure proper draining. Air piping shall pitch down in the direction of flow a minimum of 1" per 40 feet. Domestic water, chilled water, heating water, and condenser water shall slope down a minimum of 1" per 40 feet towards the drains. Wet standpipes shall pitch down to fire department connections a minimum of 1" per 40 feet. Refrigerant suction line shall slope a minimum of 1" per 10 feet towards compressor. Soil, waste, vent, and roof drain lines shall slope in accordance with

requirements of International Plumbing Code.

I. On horizontal straight runs of pipe, use eccentric reducers with straight side on top for water piping.

J. ELECTRICAL EQUIPMENT SPACES: Do not run piping in or through transformer vaults and other electrical or electronic equipment spaces and enclosures or above electrical gear unless authorized and directed. Install drip pan under piping that must be run through electrical spaces.

3.2 PIPING SYSTEM JOINTS:

A. GENERAL: Provide joints of type indicated in each piping system.

B. THREADED: Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

C. BRAZED: Braze copper tube-and-fitting joints where indicated, in accordance with ASME B31.

D. SOLDERED: Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E. FLANGED JOINTS: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

F. HUBLESS CAST-IRON JOINTS: Comply with coupling manufacturer's installation instructions.

3.3 CLEANING, FLUSHING, INSPECTING:

A. GENERAL: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31.

B. Disinfect water mains and water service piping in accordance with AWWA C601.

C. Flush, clean and treat heating and cooling systems in accordance with Sections chemical treatment. Certify by signature of Contractor and Owner's Representative.

3.4 PIPING TESTS:

A. GENERAL: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

1. Required test period is 2 hours.

2. Test long runs of Schedule 40 pipe at 150 psi, except where fittings are lower Class or pressure rating.

3. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.

4. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

B. NOTIFICATIONS: At least 10 working days prior to commencement of required testing, notice shall be submitted for review. Tests shall be made prior to painting insulating or covering of any joints and shall be in accordance with ANSI Code for Pressure Piping.

C. INSPECTIONS: Services of an authorized ASME inspector shall be furnished, not an employee of Contractor, to visually inspect piping while under hydrostatic pressure. Copies of inspection shall be submitted for review. At option of contract, welds not hydrostatically tested may be x-ray tested.

D. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

E. Drain test water from piping systems after testing and repair work has been completed.

F. Test pressure piping in accordance with ANSI B31.

G. Test waste, drain and vent systems in accordance with local plumbing code and these specifications. Repair failed sections by disassembly and reinstallation.

H. If test procedures in other sections differ from the above, comply with more stringent requirements.

END OF SECTION 221000

SECTION 221100 - FACILITY WATER DISTRIBUTION

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. This Section specifies the water distribution piping system, including potable cold, hot, and re-circulated hot water piping, fittings, and specialties within the building connecting to new equipment.

B. Water Supply Systems:

1. Domestic Water
2. Rough-in and Connect

C. Related Sections:

1. Separate sections in Division 22 specify Basic Piping Materials and Methods, Hangers and Supports, Expansion Compensation, piping system identification materials and requirements, general duty valves, pipe insulation, water conditioning equipment, domestic hot water heaters and plumbing fixtures and equipment.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications:

1. Firms regularly engaged in the manufacture of plumbing piping products and equipment of types, materials and sizes required, whose products have been in service for not less than five years.

B. Installer's Qualifications:

1. Firm with at least three years history of successful experience on projects of similar nature.

2. Licensed as a firm in the Contractor state of origin and in the State of Utah.

3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

4. All workmen employed on the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer’s technical literature indicating source, brand, type,

model, performance characteristics, installation instructions, etc. Color chart for finished surfaces and fixtures.

B. Record Drawings: See Section 220000.

C. Operation And Maintenance Information: Provide information for all equipment including a comprehensive system operating description. See Section 220100.

1.5 REFERENCES:

A. Codes and Standards: Comply with applicable sections, follow recommended practices.

1. State Boiler and Pressure Vessel Regulations
2. ASME Codes for Boilers and Pressure Vessels
3. International Plumbing Code 2021 with Utah State Amendments
4. International Building Code 2021 with Utah State Amendments
5. International Mechanical Code 2021 with Utah State Amendments
6. HI Compliance: Design, manufacture, and install plumbing pumps in accordance with HI "Hydraulic Institute Standards".
7. UL Compliance: Design, manufacture, and install plumbing pumps in accordance with UL 778 "Motor Operated Water Pumps".
8. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store pipe in a manner to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING:

A. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART II - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer Uniformity: Conform with the requirements specified in Basic Mechanical Requirements, under "Product Options."

2.2 PIPE AND FITTINGS:

A. Copper Domestic Water Pipe: (except below slab/grade)

1. Pipe Sizes 2 1/2" and Smaller: Copper tubing. Conform to ASTM B88, Type L, hard temper, copper tube;

a. Wrought-Copper Solder Type Fittings: ANSI B16.22 streamlined pattern fittings, with soldered joints using 95-5 tin antimony solder or non-lead bearing solders such at "Silvabrite."

b. Press Type Fittings: Copper and copper alloy press fittings conforming to

ASME B16.18 or B16.22 and performance criteria of IAPMO PS 117, EPDM sealing elements shall be factory installed, press ends shall have SC (Smart Connect™) feature design. Threaded fittings shall conform to ASME B1.20.1. Hangers and supports for press fittings shall comply to MSS-SP-58. Install per manufacturers written instructions and with manufacturers recommended press equipment. Approved Manufacturer: Viega Pro Press, Nibco.

2. Pipe sizes 3" and larger: Conform to ASTM 388, Type L, hard temper, copper pipes; with Victaulic couplings and fittings. Follow manufacturing requirements.

B. Stainless Steel Domestic Water Pipe: (except below slab/grade)

1. Pipe Sizes 6” and smaller (2” being the smallest allowed for this alternate): Stainless steel continuous weld tubing. Conform to ASTM A-312, A-530 and A-999, Type 304 stainless. Fittings: Constructed of Type 304 stainless steel conforming to ASTM B 366, Class WP fittings manufactured to the dimensional requirements of ANSI B 16.9 or ANSI B16.28 with pressure ratings equal to the connecting piping.

2.3 VALVES:

A. Ball valves are specified in Section 220523 – General-Duty Valves for Plumbing Piping.

PART III - EXECUTION

3.1 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.

C. Do not proceed until the unsatisfactory conditions have been corrected.

3.2 JOINING PIPES AND FITTINGS:

A. Copper Tubing: Solder joints in accordance with the procedures specified in ANSI B9.1.

3.3 PIPING INSTALLATION:

A. Refer to the separate Division 22 section: Basic Piping Materials and Methods, for general piping installation instructions.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

C. Install piping level with no pitch.

3.4 INSTALLATION OF VALVES:

A. Installation requirements for general duty valves are specified in a separate section of Division 22.

B. Valves: Install in locations shown on drawings. Provide isolation valves for brand lines and service to all equipment, shown or not.

C. Check Valves: Install swing check valves on discharge side of each pump, and elsewhere as indicated.

D. Hose Bibbs and Wall Hydrants: Install where indicated on drawings with vacuum breaker. Each and every hose bibb or wall hydrant shall have a ball valve located upstream of its individual hose bibb or wall hydrant. Locate ball valve in accessible work space.

3.5 EQUIPMENT CONNECTIONS:

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by Plumbing Code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection, provide drain valve on drain connection. For connections 2-1/2" and larger, use flanges instead of unions.

3.6 WATER SYSTEM SHOCK ABSORBERS:

A. Equip each hot and cold water connection to a fixture or faucet with a full size vertical air cushion not less than 12" long. In addition to the air cushions, provide stainless steel bellows type shock absorbers for hot and cold water at each fixture group. Zurn "Schocktrol" or Smith, Josam, Wade, size to number of fixtures.

3.7 FIELD QUALITY CONTROL:

A. Inspections:

1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

B. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

C. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

D. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the

plumbing official.

E. Reports: Prepare inspection reports, signed by the plumbing official.

F. Piping System Test:

1. Test for leaks and defects all new water distribution piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for a period of 4 hours. Leaks and loss in test pressure constitute defects which must be repaired.

4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

5. Prepare reports for all tests and required corrective action.

3.8 ADJUSTING AND CLEANING:

A. Cleaning and Disinfecting:

1. Purge all new water distribution piping systems prior to use.

2. Follow AWWA guidelines. Thoroughly sterilize the entire domestic water system with a solution containing not more than 50 parts per million of available chlorine. Introduce the chlorinating materials into the system in a manner approved by the Company's representative. Allow the sterilization solution to remain in the system for a period of 24 hours, during which time, open and close all valves and faucets several times. After sterilization, flush the solution from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million. Water system will not be accepted until a negative bacteriological test is made on water taken from the system. Repeat dosing as necessary until such negative test is accomplished.

B. Reports:

1. Prepare reports for all purging and disinfecting activities.

3.9 INSTRUCTION OF COMPANY'S PERSONNEL: Participate in specified instruction. See Section 220000.

END OF SECTION 221100

DIVISION 23
MECHANICAL

230000 General Mechanical Requirements
230100 Operation & Maintenance Manuals
230513 Motors, Drives & Electrical Requirements for Mechanical Work
230516 Meters
230523 Valves
230529 Mechanical Supporting Devices
230548 Mechanical Sound, Vibration and Seismic Control
230553 Mechanical Identification
230593 System Commissioning, Testing & Balancing
230700 Mechanical Insulation
230719 Refrigerant Piping Insulation
230900 Mechanical Control Systems
230923 Direct Digital Control Systems (DDC)
230933 Electric Control Systems
232000 General Pipes and Fittings
232300 Refrigeration Piping and Equipment
233100 Ductwork
233300 Ductwork Accessories
233713 Air Outlets and Inlets
237300 Packaged Air Handling Units
238241 Electric Heaters
2307500 Refrigerant Air Coils

SECTION 230000 - GENERAL MECHANICAL REQUIREMENTS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

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

Sections of other Divisions which relate to mechanical work apply to the work of this section. See various Sections on site work, underfloor work, structural work, finish materials, etc.

B. Related Sections: Refer to “Electrical Requirements for Mechanical Equipment” Section in Division 23 for basic electrical requirements for all mechanical equipment. Special and specific electrical requirements are specified within each respective equipment specification section.

1.2 SUMMARY: This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 230000. It expands and supplements the requirements of Division 01000.

This Division does not define, nor is it limited by, trade jurisdictions. All work described herein is a part of the General Contract and is required of the Contractor regardless.

1.3 DESCRIPTION OF PROJECT: The mechanical work described in these mechanical specifications is for a project located in West Jordan, Utah. Design weather conditions are: 96^{o} F db, 62^{o} F wb, and winter 1^{o}F. Altitude readings, unless otherwise noted, are for an elevation of 4,500 feet above sea level. Make adjustment to manufacturer's performance data as needed.

1.4 CODES AND PERMITS, AUTHORITIES HAVING JURISDICTION:

A. Perform the mechanical work in strict accordance with the applicable provisions of the various codes ordinances and adoptions pertaining to the project location in effect on the date of invitation for bids. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications govern.

B. Hold and save the Owner and Architect/Engineer free and harmless from liability of any nature or kind arising from failure to comply with codes and ordinances.

C. Secure all permits necessary for the prosecution of the work under this contract. Owner to pay all fees including connection fees related to utility hookups.

D. Reference Standards:

American Welding Society
International Mechanical Code/State Code
International Building Code/State Code
SMACNA Duct Design Standards
Local/State Plumbing Code
Locally enforced NFPA Codes

Local Fuel Utility Regulations
Local Power Utility Regulations
American Gas Association
ASME Codes for Pressure Vessels and Piping
ANSI B31.1 Piping

E. Final inspection by the Architect/Engineer will not be made nor Certificate of Substantial Completion issued until certificates of acceptability from the Authorities having jurisdiction are delivered.

1.5 DEFINITION OF PLANS AND SPECIFICATIONS: The mechanical drawings at reduced scale show the general arrangement of piping, ductwork, equipment, etc., and shall be followed as closely as the actual building construction and the work of other trades will permit. The architectural and structural drawings shall be considered as part of the work insofar as these drawings furnish the Contractor with information relating to design and construction of the building. Architectural drawings shall take precedence over mechanical drawings. Request clarification and participate in resolution in the event of conflict.

Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such extensions, fittings, valves and accessories to meet the conditions as may be required. Some small scale work is not shown such as control conduit and piping, incidental piping, specialties. Provide as directed by note or specification.

Examine the actual construction site prior to bidding and obtain an understanding of the conditions under which the work will be performed. No allowances will be made for failure to make such examination.

During construction, verify the dimensions governing the mechanical work at the building. No extra compensation shall be claimed or allowed because of differences between actual dimensions and those indicated on the drawings. Examine adjoining work on which mechanical work is dependent for perfect efficiency, and report any work of other trades which must be corrected. No waiver of responsibility for defective work shall be claimed nor allowed due to failure to report unfavorable conditions affecting the mechanical work.

1.6 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

1.7 MECHANICAL INSTALLATIONS:

A. Coordinate mechanical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

F. Coordinate the cutting and patching of building components to accommodate installation of mechanical equipment and materials.

G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

I. Coordinate the installation of mechanical materials and equipment existing with existing suspension systems, light fixtures, structures and other installations.

J. Coordinate connection of mechanical systems with existing ductwork and power. Field verify exact sizes and locations.

K. Where mechanical work penetrates other trade work such as gypboard walls, etc., penetration shall be neatly cut and walls shall be filled and patched.

1.8 ACCESSIBILITY:

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Establish required clearance to all installation features involving operation and maintenance. Respect manufacturers recommendations for access and clearance.

D. Access Doors – General: All items of mechanical equipment which may require adjustment, maintenance, replacement or which control a system function shall be made readily accessible to personnel operating the building.

1. Provide access doors in all ductwork or plenums as required to maintain fire dampers, fire smoke dampers, equipment, controls or other elements of the system. Door shall conform to SMACNA standards unless otherwise detailed or specified. Refer to 233300 for sizes.

1.9 CHANGE ORDERS: See General Conditions.

1.10 ALTERNATIVE CONSTRUCTION/SUBSTITUTION: These documents outline a way in which the Owner may be delivered a functional and reliable facility. Drawings and specifications describe reasonable engineering practice for the Contractor to follow.

Coordination between trades may result in periodic needs to adjust the installation from that indicated, but in no case shall the intended function be compromised.

The Contractor may perceive some work methods which differ from those specified which could save time and effort. These may be presented to the Architect with a breakdown of possible cost savings for review. Implement only with authorization.

Materials substitutions will generally be covered in a review process prior to bidding. After bidding, substitutions shall be proposed only on the basis of definitive cost accounting and implemented only with authorization.

1.11 CUTTING AND PATCHING:

A. Lay out the project where new work is involved ahead of time, providing sleeves and blockouts, and have work specifically formed, poured and framed to accommodate mechanical installations. Cut and patch only as needed.

B. Refer to the Division 1 Section: CUTTING AND PATCHING for general requirements for cutting and patching.

C. Refer to Division 26 Section: BASIC ELECTRICAL REQUIREMENTS for requirements for cutting and patching electrical equipment, components, and materials.

D. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

E. Arrange for repairs required to restore other and any work damaged as a result of mechanical installations.

F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

G. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;

2. Remove and replace defective Work;

3. Remove and replace Work not conforming to requirements of the Contract Documents;

4. Remove samples of installed Work as specified for testing:

5. Install equipment and materials in existing structures.

H. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

I. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping and other mechanical items made obsolete by the new Work.

J. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

K. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1.12 SUBMITTALS: Submittal of shop drawings, product data, and samples will be accepted only from the Contractor to the Architect. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed. Document each transmittal and sign and stamp the submittal indicating that it has been reviewed and is in compliance with the criteria of the project, any exceptions being clearly noted.

A. Shop Drawings: As soon as possible after the contract is awarded, submit to the Architect, electronic copies – pdf format of the descriptive literature covering all equipment and materials to be used in the installation of mechanical systems for this project. Written confirmation of acceptable review by the Owner's Representative shall be obtained before ordering, purchasing, acquiring or installing any such equipment or materials for the project.

Prepare the submittals in an orderly manner after the order of this specification, with identification tabs for each item or group of related items. Submitted literature shall clearly indicate performance, quality, utility requirements, dimensions of size, connection points and other information pertinent to effective review.

Equipment must fit into the available space with allowance for operation, maintenance, etc. The Contractor shall take full responsibility for space and utility requirements for equipment installed.

Factory-wired equipment shall include shop drawings of all internal wiring to be furnished with unit.

Review of the Architect/Engineer is for general conformance of the submitted equipment of the project specification; in no way does such approval relieve Contractor of his obligation to furnish equipment and materials that comply in detail to the specification, nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions which may affect his work.

B. Record Drawings: During the course of construction, maintain a set of drawings, specifications, change orders, shop drawings, addenda, etc., for reference and upon which all deviations from the original layout are recorded. Turn these marked-up documents over to the Architect/Engineer at the conclusion of the work so that the original tracings can be revised. If the Contractor fails to mark up the prints, reimburse the Architect/Engineer for time required to do so.

1.13 OPERATION AND MAINTENANCE TRAINING:

A. Instruction of Owner's Personnel: At a time prior to Owner making use of a device or system, and in general after testing and balance work for a major system is complete, prepare, schedule and conduct a series of training sessions for Owner's operating and supervisory personnel. Instructions shall cover each device and system with emphasis on understanding of the purpose and function, the maintenance requirements and the proper adjustment and operating technique.

B. Instruct building operating staff in operation and maintenance of modified mechanical systems utilizing Operation and Maintenance Manual when so doing.

C. Minimum instruction periods shall be as follows:

1. Mechanical - eight hours total or as needed.

2. Temperature Control - eight hours total or as needed. Programming help as needed.

D. Initial instruction periods shall occur after pre-final inspection when systems are working properly and before final payment is made. Schedule subsequent visits with the Owner's Building Operation Personnel throughout the first year.

E. None of these instructional periods shall overlap with another.

F. Vendors for each piece of equipment controls, etc., shall participate along with the Contractor(s).

1.14 GUARANTEE/WARRANTY: The following guarantee is a part of this specification and is binding on the part of the Contractor and his assigns:

"Contractor guarantees that this installation is in accordance with the terms of the Contract and is free from mechanical defects. He agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance. See also the General Conditions of these specifications. Failed equipment in the repair or replacement shall be guaranteed for one full year from the date of re-commission."

Compile and assemble the warranties required by Division 23 into a separated set of vinyl covered, insert sheets, tabulated and indexed for each reference, included in the O & M Manual.

Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

Mechanical systems and equipment shall not be considered for substantial completion and initiation of warranty until they have performed in service continuously without malfunction for at least thirty (30) working days.

1.15 TESTS AND CERTIFICATIONS: Make all tests required by code or specification in the presence of a representative of the Owner, with tests recorded and certified by the Contractor and Representative. Involve local authorities where required.

1.16 PERMITS, FEES, LICENSES: Refer to General Conditions. See Paragraph 1.4.

1.17 MECHANICAL COORDINATION DRAWINGS: For the mechanical rooms, congested areas, or areas of great detail, prepare and submit a set of coordination drawings showing major elements, components and systems of mechanical equipment and materials in relationship with the existing building components (structure, fire sprinkler, electrical, etc.). Prepare drawings to an accurate scale of 1/4" - 1-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing, servicing, and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment through the existing building opening(s).

Prepare floor plans, elevations, sections and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

A. Fan rooms, mechanical equipment rooms:

1. Supply fans, plenums, etc.
2. Cooling coils, filters, etc.
3. Packaged air handling unit.
4. All piping.
5. Specialty systems.
6. Electrical installations.
7. Related structure.

B. Work in trenches and tunnels.

C. Exterior wall penetrations.

D. Installations of piping, ductwork, piping racks, structure. Provide sections and additional detail at crucial offsets and junctures.

E. Exterior underground lines in common excavation.

F. General floor plan layouts with ductwork, piping, lighting, structure, etc.

G. Use drawings to coordinate all affected trades. Do not work without coordinated drawings.

1.18 SCHEDULING/METHODS OF PROCEDURE: Where interruptions of service are needed to affect work of this contract, outline the work, coordinate with other trades, determine the Owners acceptable downtime and prepare a time based schedule to accomplish the work. Give notice of a necessary utility interruption (or shutdown) to any existing system to the owner’s construction coordinator not less than 72 hours prior to the proposed shutdown. This will then be coordinated with Jordan Valley Water Conservancy District (JVWCD) for approval to go ahead with the shutdown or re-schedule. Set up evening, nighttime or weekend hours as necessary to accomplish the work with minimum disruption.

PART II - GENERAL MECHANICAL MATERIALS AND METHODS

2.1 QUALITY OF MATERIALS AND EQUIPMENT:

A. All equipment and materials shall be new and shall be the standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment, and shall be the manufacturer's latest design. Specific equipment shown in schedules on drawings and specified herein is to be the basis for the Contractor's bid. Provisions for substitute equipment are outlined in the General Conditions. All materials shall be produced by manufacturing plants located in the United States of America. Do not use foreign manufactured products. Any request for deviation from this requirement is to be made prior to bid time through a detailed request for substitution/prior approval process. Requests made after bid time will not be accepted.

B. Furnish and install all major items of equipment specified in the equipment schedules on the drawings complete with all accessories normally supplied with catalog items listed, and all other accessories necessary for a complete and satisfactory installation.

2.2 PROTECTION OF MATERIALS AND EQUIPMENT:

A. Close pipe and duct openings with caps or plugs to prevent lodgement of dirt or trash during the course of installation. Cover equipment tightly and protect against dirt, water and chemical or mechanical injury. Plumbing fixtures intended for the final installation shall not be used by the construction forces. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly and deliver in a factory dock condition for the Owner's acceptance. Make damage and defects developing before acceptance of the work good at Contractor's expense.

B. Do not make temporary use of project equipment, new or existing, during construction without the written consent of the owner. Systems shall not be used for temporary heat or cooling. When the contractor is permitted to use the heating and ventilating system during the course of construction, he shall operate the equipment in accordance to University standards during this time. This shall consist of properly treating water, maintaining filters, cleaning traps and screens, lubricating bearings and all other instructions from the manufacturer and JVWCD.

2.3 QUALIFICATIONS OF WORKMEN:

A. All mechanics shall be capable journeymen, skilled in the work assigned to them. Apprentices may be used with appropriate direction.

B. Employ no unskilled persons in the work which he is given to do; execute all work in a skillful and workmanlike manner. All persons employed upon this work shall be competent, faithful, orderly and satisfactory to the Owner. Should the Owner's Representative deem anyone employed on the work incompetent or unfit for his duties, and so certify, Contractor shall dismiss him and he shall not be again employed upon the work without permission of the Owner's Representative.

C. All welders involved in welding of pressure piping systems shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Written verification of successful test completion shall be submitted to Architect prior to initiating work.

2.4 FOREMAN: Dedicate and designate a full-time general mechanical foreman to the Owner's Representative to be consistently available on site during the life of the project for consultation. Do not replace this individual without prior approval from the Owner's Representative.

2.5 USE OF COMMON VENDORS: Regardless of subcontract delegations, coordinate purchasing between trades so that equipment and materials of similar nature come from a single vendor, i.e., all package HVAC terminal units shall be common source. Valves, terminal boxes, speed drives, etc., the same. Do not burden the Owner with multiple brands of similar equipment unless so directed.

2.6 WALL PENETRATIONS - FLASHINGS:

A. Use Schedule 40 galvanized steel pipe for all pipe sleeves.

B. Let pipe sleeves allow for movement of the pipe due to expansion and contraction, yet to include seismic restraint.

2.7 EXCAVATING AND BACKFILLING (GENERAL):

A. Provide all excavation, trenching and backfilling for Division 230000 underground piping work.

B. After work has been tested, inspected, and approved by the Owner's Representative and/or State/Local Inspector, and prior to backfilling, clean the excavation of all rubbish, and clean backfill materials free of trash. Place backfill in horizontal layers not exceeding 12" in thickness, properly moistened. Mechanically compact each layer with suitable equipment to a dry density of not less than 95 percent as determined by the Modified AASHO Test T-18O.

1. Protect from damage all existing underground utilities or utility tunnels indicated on the contract drawings (or field located for the Contractor by the Owner prior to excavation operations). Any damage to identified existing utilities or utility tunnels shall be repaired by the Contractor at no cost to the Owner.

2.8 HANGERS AND SUPPORTS (GENERAL):

A. Provide hangers and/or supports for all equipment, piping and ductwork. Primary information is contained in these specifications and on the drawings.

B. Provide hangers and supports to correlate with seismic restraint and vibration isolation.

C. Reuse existing anchor points where possible.

2.9 MANUFACTURER'S DIRECTIONS: Install all equipment in strict accordance with directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the plans and specifications, report such conflicts to the Architect who shall direct adjustments as deemed necessary and desirable.

2.10 LUBRICATION: Lubricate equipment at startup. Then, provide all lubricants for the operation of all equipment until acceptance by the Owner. The Contractor is held responsible for all damage to equipment and bearings while the equipment is being operated by him consequent to pre-acceptance operation.

2.11 ELECTRICAL WIRING AND CONTROL:

A. In general, motor starters, related motor starter equipment and power wiring indicated on the electrical drawings and control diagrams are to be furnished and installed under Division 260000 of this Specification. Items of electrical control equipment specifically mentioned to be furnished by the Division 230000 either in these specifications or on the electrical or mechanical drawings, shall be furnished and mounted by this Contractor and shall be connected under and as required by this Division 230000 and Division 260000 of these specifications.

B. Refer to the control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the contractor.

C. Division must be fully coordinated with Division 260000 to ensure that all required components of the work are included and fully understood. No additional cost shall accrue to the Owner because of lack of coordination.

D. Where the detailed electrical work is not shown on the electrical drawings, the Mechanical Contractor shall furnish, install and wire or have prewired all specified and necessary controls for air handling equipment specified for this project. The objective of this paragraph is to make sure a complete operating system is obtained at no additional cost to the Owner for field wiring required related to the equipment.

2.12 FLUSHING AND DRAINING OF SYSTEMS/CLEANING OF PIPING AND DUCTS: Blow out refrigerant piping systems with compressed air or nitrogen to remove foreign materials that may have been left or deposited in the piping system during its erection. Duct systems shall have all debris removed and fans shall be run to blow out all dust and foreign matter before grilles, outlets or mixing boxes are installed and connected.

Damp wipe all ductwork on installation, cap open ducts, cover fan inlets, vacuum fan plenums and related installation before starting fans. Run fans only with filters in place.

2.13 JOBSITE CLEANUP:

A. Keep site clean during progress of work.

B. At the conclusion of work, clean all installation thoroughly.

1. Leave equipment in a factory dock condition. Correct any damage and touch up or repaint if necessary.

2. Remove all debris from site.

END OF SECTION 230000

SECTION 230100 - OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-23 General Mechanical Requirements sections apply to work of this section.

1.2 SUMMARY:

A. Furnish one set of bound operation and maintenance manuals. Furnish one copy of operation and maintenance manual in electronic, pdf version on CD disk. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to maintain and repair the equipment. Copies of approved submittals shall be included for all equipment.

1.3 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS:

A. General:

1. The "Operating and Maintenance Manual" is a bound compilation of drawings and data that the owner requires for each building or project. These manuals, complete with drawings and data, shall be furnished to the Owner.

2. The mechanical contractor has overall responsibility to obtain the necessary data and compile the data as set forth in this specification, including items or equipment purchased by the Owner and delivered to the contractor for installation.

3. Catalog the information in folders grouping equipment by project specification number.

4. Make all information legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of mechanical and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART II - MATERIALS AND METHODS

2.1 PAGE SIZE: All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 16 x 11 inches) folded to 8-1/2 x 11 inch.

2.2 DRAWINGS: All drawings larger than 8-1/2" x 11" shall be folded and inserted in individual 8-1/2" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.3 BINDERS: Binders shall be 8-1/2 x 11 inch, 3 ring ridged type “D” with clear plastic cover and backbone for slip in title information 2" to 3" rings as required for the project. The number of binders, however, shall be based on not filling them beyond 2-1/2" thickness.

A. Place the following information on 8-1/2” x 11” white paper to slip into plastic covers on front and backbone:

1. "Operation and Maintenance Manual".

2. Project Name (and volume number if more than one volume).

3. Project Number (Per JVWCD project number).

4. Building name and number.

5. Owner’s name.

6. Engineer's name.

7. General Contractor's name.

8. Mechanical Contractor's name.

9. Items 6 through 8 need not be printed on the backbone.

2.4 CONTENTS AND INDEXING:

A. Manuals shall contain descriptions of the building systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:

1. Copy of purchase order change (if any).

2. Outline drawings, special construction details, “as built” electrical wiring and control diagrams for all major and supplementary systems.

3. Manufacturer’s test or calculated performance data and certified test curves.

4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.

5. Manufacturer's brochure marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included.

6. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.

7. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:

   a. Part I Building and System Descriptions
   b. Part II Purchased Equipment Data
   c. Part III Test Reports and Valve Charts
   d. Part IV Start-Up and Operation
   e. Part V Preventative Maintenance Recommendations

8. A copy of the approved submittals for each piece of equipment.

9. A copy of all testing, adjusting and balancing reports.

10. Wiring diagrams, marked with model and size and plan symbol.

11. The index shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.

END OF SECTION 230100

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SECTION 230513 - MOTORS, DRIVES & ELECTRICAL REQUIREMENTS FOR MECHANICAL WORK

PART I - GENERAL

1.1 RELATED DOCUMENTS:

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

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 16.

1.2 SUMMARY:

A. This section specifies the basic requirements for motors and drives furnished by this Division and for electrical components which are an integral part of packaged mechanical equipment. Package components include, but are not limited to factory installed motors, starters, and disconnect switches, etc.

B. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are noted within these documents.

1.3 QUALITY ASSURANCE:

A. Provide electrical components and materials which are UL labeled.

B. Provide variable speed drives which conform to the latest standard of the following:

1. IEEE - Institute of Electrical and Electronic Engineers.

2. NEC - National Electrical Code.

3. NEMA - National Electrical Manufacturers Association.

4. Provide complete packaged unit(s) which are listed and carry the label of at least one of the following:

a. UL - Underwriters Laboratory
b. ETL - ETL Testing Laboratories, Inc.
c. CSA - Canadian Standards Association

1.4 SUBMITTALS:

A. The air handling unit vendor shall submit complete product and application information for variable speed drives as follows:

1. Provide multiple sets of drawings of system (VFD) being supplied, in strict compliance with the specifications. Include, as a minimum:

a. General arrangement of each unit showing size and incoming and outgoing conduit locations.

b. Schematic.

c. Connection diagram, sufficient to install drive system.

2. Provide each unit with four owner/maintenance manuals which shall include:

a. Vendor information of equipment being supplied.

b. Connection information.

c. Start up procedure.

d. Fault reset instruction.

e. Wiring diagrams (power and control).

f. Parts list.

g. Test results.

h. Harmonic voltage distortion online with unit off.

i. Harmonic voltage distortion with unit online.

B. Submit product data for motors, belts, drives, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections. Verify project electrical characteristics with submittal. Confirm suitability for altitude, maintaining full nameplate rating plus service factor. Include this data in the maintenance manual in accordance with Section "Operation and Maintenance Manuals".

1.5 REFERENCES:

A. NEMA Standards MG 1: Motors and Generators.

B. NEMA Standards ICS 2: Industrial Control Devices, Controllers, and Assemblies.

C. NEMA Standards 250: Enclosures for Electrical Equipment.

D. NEMA Standards KS 1: Enclosed Switches.

E. Comply with National Electrical Code (NFPA 70).

1.6 WARRANTY:

A. General: For variable frequency drives, the air handling unit vendor shall furnish a written warranty consisting of the following:

1. Warranty parts and labor for five years after substantial completion.

PART II - PRODUCTS

2.1 MOTORS:

A. The following are basic requirements for simple or common motors provided with the air handling unit, condensing unit, or heat pump units. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

2. Motor sizes large enough so that the driven load will not require the motor to operate in the service factor range.

3. Two-speed motors with 2 separate windings for poly-phase motors. Confirm 2-speed starter requirements with Division 26.

4. Single speed motors of the permanent split capacitor type. (PSC)

5. Temperature Rating: Minimum rate for 40°C environment with maximum 90°C temperature rise for continuous duty at full load (Class H Insulation for altitude, Class B leads allowed).

6. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly timed spaced starts per hour for manually controlled motors.

7. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors, 1.0 for TEFC motors.

8. Pump motors with an end shield with ventilation openings beneath the motor.

9. Motor Construction: NEMA Standard MG 1, general Purpose, continuous duty, design "B", except "C" where required for high starting torque.

10. Frames: NEMA Standard No. 48 or 54; T-frame, use driven equipment manufacturer's standards to suit specific application.

11. Bearings:

a. Ball or roller bearings with inner and outer shaft seals;

b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance;

c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor;

d. For fractional horsepower, light duty motors, sleeve type bearings are permitted;

e. All Motors supplied for VFD applications shall include insulated bearings.

12. Enclosure Type:

    a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation;
    b. Guarded drip-proof motors where exposed to contact by employees or building occupants;

    c. Weather protected type I for outdoor use, Type II where not housed;

13. Overload Protection: built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.

14. Noise Rating: "Quiet"

15. Efficiency: "Premium Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112. Motors used with Variable Frequency Drives shall be compatible and designed for use with Variable Frequency Drives. Any “explosion proof” motor for classified areas, scheduled for use with VFD’s, shall be listed for invertor duty applications.

16. Nameplate: indicate the full identification of manufacturer. ratings, characteristics, construction, special features and similar information.

17. Acceptable Manufacturers: Allis-Chalmers, Baldor, Century, General Electric, Gould, Lincoln, Louis-Allis, Marathon, Reliance, U.S. Motors, Westinghouse.

2.2 MOTOR DRIVES: (Furnished with the Air Handling Unit.)

A. Provide fan/motor drives with cast steel sheaves and V-belt sets of fabric and rubber construction by Browning, Dodge, Woods. Match multiple belts and adjust to drive the apparatus properly and to prevent slippage and undue wear in starting. Design drives for 150 percent or more of the specified motor nameplate rating. Bush all drives. Belts shall be A, B or C section belts. Narrow gauge belts are not acceptable. Adjust drives or replace sheaves as needed to obtain required capacities.

B. Provide flexible coupled drives for pumps by Browning, Dodge or Woods.

C. Provide a galvanized iron metal guard for each V-belt drive, coupled drive or rotating shaft constructed around an angle iron frame, securely bolted to the floor or apparatus. Design the guard to completely enclose drives and pulleys and be constructed to comply with all safety requirements. Provide hinged access doors not less than 6" x 6" for access to motor and fan shaft for test purposes. For double inlet fans, construct the belt guard cover of 1/2" mesh expanded metal, arranged as not to restrict the air flow into the fan inlet.

2.3 VARIABLE FREQUENCY DRIVES:

A. General: The air handling unit vendor shall furnish Variable Frequency Drive with associated control signal components, harmonic filtering, power factor compensation and related cabinets, devices, ventilation, etc. Sizes and capacities as scheduled on the drawings. Rate drive for constant torque application with variable torque application

capability. Drive shall be warrantied for parts and labor for 5 years after substantial completion. Drives shall be wired for full VFD rating.

1. Verify compatibility of VFD System being supplied with the related equipment motor. If a new motor is being supplied supply the VFD to match the new motor(s) and warranty the Drive to be compatible with that motor.

2. Furnish system in a NEMA 1 enclosure, either wall-mounted or free standing, with fan forced, filtered ventilation.

3. Furnish system with silk screened or engraved labels on all door operator and pilot devices, attached with screws, rivets or adhesive.

4. Provide an electrical shock warning label on each system to warn personnel that a potential of electric shock exists.

5. Furnish system complete, wired with all components assembled in a single enclosure including, but not limited to the VFD units, contactors, door interlocked circuit breaker. Units requiring mounting and interwiring of separate bypass enclosure are not under this specification.

6. Supply a complete set of engineering drawings consisting of, as a minimum, general arrangement, power wiring diagram, control wiring diagram and schematic of VFD System components, options, and equipment and tests included to meet power quality requirements of the specification.

7. Furnish an owner's manual consisting of catalog sheets showing actual components and parts numbers. Manual shall also show test certificates, warranty and service personnel responsible for warranty.

8. Furnish factory trained VFD System installation and start-up and warranty service. Mount unit and connect to power supply, mount and wire remote devices.

B. Construction: Assemble the Variable Frequency Drive unit and components in a NEMA 1 enclosure.

1. The Variable Frequency Drive inverter shall be altitude compensated and sized for the elevation at which the unit will be installed. The inverter shall operate in an ambient temperature of -10^{o}C to 50^{o}C and a humidity of 0 to 90 percent non-condensing.

2. Mount the Variable Frequency Drive inverter unit on a removable panel along with all other components such that, if required, the panel can be removed from the enclosure for maintenance or part replacement.

3. Mount the door with a minimum of two hinges with removable pins. Door shall be rigid and large doors shall have additional hinges and stiffening steel.

4. Paint enclosure, two coats over primer, with high grade enamel, a minimum of 50-70 microns thick.

5. The enclosure shall be force ventilated and the exhaust ports covered with

louvers. All components of the system, except sensors, shall be contained in this single enclosure as an integrated package.

6. Door mounted operator devices shall be industrial, oil tight, equivalent to control center devices.

7. Control power for operator devices and customer connections shall be 120 volts. The control power transformer shall be a "Machine Tool" type and have both primary and secondary fusing.

C. Standard Features: Provide the following features as standard on all VFD units furnished.

1. The VFD unit shall be a solid state AC to DC converter sinusoidal pulse-width modulation (PWM) type, with an altitude adjusted horsepower rating equal to or greater than the motor HP that the unit is supplying or not less than the scheduled rating, whichever is greater.
2. Electrical characteristics:

   a. Input Voltage 460 VAC +/- 10% (Nominal 480 Volts)
   b. Input Frequency 60 Hz +/- 5%

3. Motor braking torque available by means of regenerative braking.

4. An output frequency clamp such that minimum or maximum output frequency can be set at desired limits.

5. Rated overload current shall be 150% for one minute.

6. Adjustable acceleration/deceleration time setting from one second to 120 seconds.

7. A 95 percent or better displacement power factor over the entire speed range.

8. A 95 percent or better output/input efficiency over the entire speed range.

9. A door interlocked input disconnect motor circuit protector. The MCP shall allow trip adjustment sufficient to start the motor across the line in the bypass mode and normally be set at a minimum setting for maximum protection in the VFD mode. The door mounted handle shall be lockable in the off position.

10. The following door mounted operator controls as a minimum:

    a. Hand/Off/Auto Switch - keyed switch required.
    b. Local/Remote Switch - keyed switch required.
    c. Frequency Setting - through programmable controller pad.
    d. Frequency Indication Meter Calibrated in % Speed - through programmable controller pad.
    e. Power on Light
    f. VFD Enable Light
    g. VFD Fault Light
    h. External Fault Light (safeties interlock)

11. A minimum of the following protective features with an alarm display indication:

    a. Overcurrent Shut-off
    b. Regenerative Overvoltage
    c. Electronic Thermal Protector
    d. Heatsink Overheat
    e. Instantaneous Power Failure
    f. Ground Fault

12. The following termination points on terminal strip for field connections:

    a. Safeties Interlock
    b. Remote Start/Stop Contact
    c. Remote VFD Fault Contacts (N.C.)
    d. Remote VFD/Bypass Enable Contacts (N.O.)
    e. Remote Electronic Signal Input

13. Auto restart initiation by means of an automatic time delayed restart after recovering from undervoltage or loss of power. The inverter shall have auto restart compatibility with power provided by standby engine generator system provide all required components to insure compatibility to operate on standby engine power. The invertor shall not automatically restart after overcurrent, overvoltage, overtemperature, or any other damaging conditions but shall require a manual restart.

14. Remote input signal connection terminals (0-5 VDC or 0-10 VDC = 0-100% speed or 4-20 mA = 20-100% Speed).

D. Additional Configuration Features:

1. Bypass Option: Equip the inverter with a manual bypass contactor arrangement for transfer to the feeder line to operate at constant speed. The contactors shall be electrically and mechanically interlocked and supplied with an adjustable motor overload.

2. Provide a VFD isolation switch to allow maintenance on the VFD while in the bypass mode. Furnish prewired in the same enclosure, including contactors, VFD isolation switch, motor overload VFD/Bypass selector switch and Bypass ON light.

3. Digital or Analog Ammeter, through programmable key pad.

4. Digital or Analog Voltmeter, through programmable key pad.

5. Frequency Jump: Furnish a frequency jump control to avoid operating at a point of resonance with the natural frequency of the machine.

6. Provide series line reactors for harmonic distortion control as standard equipment.

7. Drive Speed Control, I/E or I/I or E/E or E/I transducers as needed.

8. Synchronous transfer to allow transfer from VFD to utility line and back to VFD unit while motor is running.

9. Provide Bac Net interface card for interface to the building automation system through the Ethernet network.

10. Remote Digital/Analog Speed Meter with 4-20 ma signal. Locate at central control console.

11. Each VFD shall have a built-in disconnect.

E. Acceptable Manufacturers: Acceptable manufacturers of VFD equipment shall meet the following requirements.

1. Suppliers of VFD Systems must be in the primary business of supplying Variable Frequency Drives and have a minimum of five (5) years of service in that business.

2. Vendor must have local service center with factory spare parts inventory and factory authorized service technician on call 24 hours/day.

3. VFD units supplied in response to this specification shall be labeled by UL, CSA or ETL. Note the entire unit shall carry the label not just a component.

4. The following VFD suppliers are acceptable providing that all points of this specification are adhered to:

a. ABB.
b. Energy Management Corporation using Mitsubishi drives.
c. Yaskawa.

5. VFD vendors must have prior approval from Owner before quoting equipment specified. If not listed above, vendor must apply to Owner for approval 10 days prior to bid date showing point by point compliance with this specification including sample of typical harmonic voltage distortion test report. In compliance with general requirements of the specification.

F. Testing: Prior to shipping, test each unit and submit certified test report with each unit. Standard tests to include:

1. Visual inspection, consisting of checking unit enclosure, wiring, connections, fasteners, covers and locking mechanism.

2. High pot test; two (2)X rated voltage plus 1000 volts AC for 60 seconds shall be applied per UL 508 on all perifial drive system power components (circuit breakers, contactors, motor overloads, line reactors, disconnect switches, etc.) as a complete package. A copy of test results shall be included in operation manuals.

3. Motor run test.

4. Control panel devices, test all devices and lights.

5. Optional equipment, test optional equipment specified with VFD system.

6. Special tests, as required and specified.

G. Installation: Field mounting pad and power connections shall be provided by contractor.

1. Vendor shall supply field start-up service by an authorized factory service representative consisting of system check-out, start-up and system run. The vendor shall provide warranty and authorized factory service including operator training. A written certificate of same shall be provided at start-up. Provide written certified start-up report. VFD service technicians shall be full time employees of the vendor or manufacturer, primarily engaged in VFD service work during normal business hours but on call 24 hours. Start-up by sales representative is not acceptable.

2. Startup/adjustment effort shall have at least two segments.

   a. Prior to Test and Balance work to place equipment in operation.

   b. At conclusion of Test and Balance work to adjust units to actual operating conditions.

3. The following adjustments and tests shall be performed as a minimum with certified copies included in the maintenance and operation manual.

   a. Verify that the input voltage is within the manufacturer's specification tolerances.

   b. Verify that the motor rotation is correct in all modes of operation.

   c. Verify all operator devices, programming and monitoring functions to be fully operational.

   d. Verify operation of all field signal control connections.

   e. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.

   f. Make all parameter adjustments to tune and optimize the VFD system to the application. Record all configuration values as part of this report.

   g. Conduct harmonic tests as identified in the specification. Measurements shall be recorded for each unit with the VFD system off, running at 50% speed, and running at full speed and load.

END OF SECTION 230513

SECTION 230516 - METERS

PART 1 GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install following meters as described in Contract Documents.
      a. Air Flow Measuring Stations

B. Related Sections
   1. Section 23 0500 - General Mechanical Requirements
   2. Section 23 2100 - General Piping Requirements
   2. Section 23 3100 - General Duct Requirements

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Airflow/Temperature Measurement Station (AFM-)
   1. Airflow/Temperature Measurement - General. The airflow/temperature measurement station(s) indicated on the plans shall be capable of monitoring airflow and temperature rates at each measurement location. Sensors shall use thermal dispersion technology with two bead in glass", hermetically sealed thermistor probes at each measurement point. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines. Each sensor probe shall be provided with a UL plenum-rated connecting cable with circular terminal connectors and gold plated contacts. Connecting cable shall be a minimum of 50 feet in length for each probe. Sensor probes shall be "plug and play" design without having to be matched to a specific transmitter. All sensor calibration data shall be stored in the sensor probe. No additional devices or transducers shall be required to interface with the host controls. Sensors shall be factory-calibrated at 16 airflow rates and 3 temperatures to NIST-traceable standards for both airflow and temperature. Each sensing point shall independently measure airflow and temperature prior to averaging.
      Installed accuracy shall be percent of reading and demonstrated at both maximum and minimum airflow rates for each measurement location.

   2. Transmitter and Electronics Enclosure
      The transmitter shall be microprocessor-based and capable of processing up to 16 independent sensing points per location. All connectors and interconnects shall have gold plated contacts. The transmitter shall operate on 24 VAC and be internally fused and protected. The transmitter shall have a 16 character alphanumeric LCD display for airflow, temperature, and system diagnostics. Analog output signals shall be field selectable (0-10 VDC or 4-20 mA). All inputs and outputs shall be fused, protected, and internally isolated from the 24 VAC power supply. The transmitter shall have a digital adjustment for output signal offset/gain and an adjustable digital filter for airflow output. The transmitter shall be capable of displaying I.P. units. The

transmitter shall accept a user-defined area for CFM display. The transmitter shall be capable of continuously performing sensor and transmitter diagnostics and perform a full system check on power-up. A sensor detection system shall ignore any malfunctioning sensors and set a visual alarm on the LCD display. The transmitter shall be capable of indicating individual sensor airflow and temperature readings on the LCD display. The enclosure shall be aluminum alloy for indoor use and capable of operating over a temperature range of +30° F to +120° F. The electronics shall be installed inside and protected from the weather.

3. Duct & Plenum Mounted Sensor Probes
   Sensor probes shall be constructed of gold anodized aluminum alloy tube with 303 stainless steel mounting brackets. Probes shall be constructed as insertion, internal, or standoff mounting, depending on the installation requirements.
   a. Probe Performance Requirements-
      The sensor accuracy for airflow shall be at least +/- 2% of Reading over the sensor probe operating ranges. The installed total accuracy for airflow shall be better than ∀3% of Reading over the sensor probe operating ranges when installed in accordance with manufacturers' guidelines. The sensor accuracy for temperature shall be better than +/- 0.15° F over the entire operating range.
   b. Probe Sensor Density

Area (sq.ft.)	Sensors
</= 1 -	2
1 to < 4 -	4
4 to < 8 -	6
8 to < 12 -	8
12 to < 16 -	12
>=16	

   c. Probe Operating Ranges:
      Airflow: 0 to 5,000 FPM
      Temperature: -20° F to +160° F
      Relative Humidity: 0 to 99% (non-condensing)
4. Approved Manufacturers and Equipment
   a. EBTRON Gold Series model.
   b. Ruskin.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install airflow measuring station per manufacturer instructions. Provide required upstream and downstream duct diameters.

END OF SECTION 230516

SECTION 230523 - VALVES

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-23 Valves section and is part of each Division-23 section making reference to valves specified herein.

C. Division-23 General Mechanical Requirements apply to work of this section.

1.2 SUMMARY:

A. Extent of valves required by this section is indicated on drawings and/or specified in other Division-23 sections.

B. Types of valves specified in section include the following:

1. Drain Valves.
2. Ball Valves.

C. Valves furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.

1.3 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Valve Types: Provide valves of the same type by same manufacturer.

C. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing Manufacturer's figure number, size, location, and valve features for each required valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data, product data, and shop drawings in Maintenance Manual, in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".

2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

3. UL and FM Compliance: Provide valves used in fire protection piping, which are UL-listed and FM approved.

PART II - PRODUCTS

2.1 VALVES:

A. General: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

B. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.

C. Operators: Provide lever handle for quarter-turn valves, 4" and smaller.

D. Connections: Provide ball valves with threaded connections..

2.2 CONDENSATE DRAINAGE:

A. Ball Valves:

1. Copper piping 2” and smaller: 400 psig WOG @ 250ºF bronze construction, threaded or solder ends, bubble tight mineral filled. PTFE seat at 250 psig under water, hard stainless steel ball and stem, full port, identification tag. Operate with flow in either direction. Lever or tee handle as required. Suitable for tight shut-off.

a. Approved Manufacturers: No other manufacturers approved. All drain valves shall be furnished with capped 3/4” threaded hose outlet connection and cap chain.

(1) Apollo 77-140 /77-240 or 70-140/70-240
(2) Milwaukee BA-400S / BA-450S or BA150S/BA-100S
(3) Hammond 8303A/8313A or 8503A/8513A
(4) Nibco T/S-585-70-66.

PART III - INSTALLATION

3.1 VALVE INSTALLATION:

A. Locate drain valve in location which will allow easy operation and facilitate maintenance.

B. Install drain valve with stems horizontal or above.

END OF SECTION 230523

SECTION 230529 - MECHANICAL SUPPORTING DEVICES

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-23 Mechanical Supporting Devices section, and is part of each Division-23 section making reference to supports and anchors specified herein.

C. Division-23 General Mechanical Requirements apply to work of this section.

1.2 SUMMARY:

A. Extent of supports and anchors required by this section is indicated on drawings and/or specified in other Division-23 sections.

B. Types of supports and anchors specified in this section include the following:

1. Horizontal-Piping Hangers and Supports.
2. Vertical-Piping Clamps.
3. Hanger-Rod Attachments.
4. Building Attachments and In-Beds.
5. Saddles and Shields.
6. Miscellaneous Materials.
7. Anchors.
8. Equipment Supports.

C. Supports and anchors furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.

D. Relate this section to Section 230548 regarding seismic and vibration control.

1.3 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

B. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and parts list for each type of support and

anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. Code Compliance: Comply with applicable building, mechanical and plumbing codes pertaining to product materials and installation of supports and anchors.

2. UL and FM Compliance: Provide products which are UL-listed and FM approved.

3. MSS Standard Compliance:

a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

b. Select and apply pipe hangers and supports, complying with MSS SP-69.

c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.

d. Terminology used in this section is defined in MSS SP-90.

PART II - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS:

A. General: Support, guide, restrain and generally manage all piping installed on the project. Except and unless otherwise indicated, provide factory fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddles or shields for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.

Horizontal pipe supports shall be spaced as specified in the tables in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe support spacing shall be as required for specified hydrostatic tests.

Note the requirement to accommodate expansion and contraction, both horizontal and vertical, of hot and cold piping as a part of the overall installation.

1. Pipe supports shall be spaced not over 5 feet apart at valves.
2. In the support of multiple pipe runs on a common base member, a clip or clamp

shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 1/8 inch shall be provided between the pipe and clip or clamp for piping which may be subjected to thermal expansion

B. Adjustable Steel Clevises Hangers: MSS Type 1. (For suspension of non-insulated or insulated stationary pipe lines; 1/2" to 30".)

C. Steel Double Bolt Pipe Clamps: MSS Type 3. (For suspension of pipe requiring up to 4" of insulation and where flexibility of clamp is desirable; 3/4" to 24".)

D. Steel Pipe Clamps: MSS Type 4. (For suspension of cold pipe lines or hot lines where little or no insulation is required; 1/2" to 24".)

E. Pipe Hangers: MSS Type 5. (For suspension of piping when off-center closure allowing installation of hanger before erection of piping is desired; 1/2" to 4".)

F. Adjustable Swivel Pipe Rings: MSS Type 6. (For suspension of non-insulated stationary pipe lines; 3/4" to 8".)

G. Adjustable Steel Band Hangers: MSS Type 7. (For suspension of non-insulated stationary pipe lines; 3/4" to 8".)

H. Adjustable Band Hangers: MSS Type 9. (For suspension of non-insulated stationary pipe liens; 1/2" to 8".)

I. Adjustable Swivel Rings, Band Type: MSS Type 10. (For suspension of non-insulated stationary pipe lines; 3/8" to 8".)

J. Split Pipe Rings: MSS Type 11. (For suspension of non-insulated stationary pipe lines; 3/8" to 3".)

K. Extension Split Pipe Clamps: MSS Type 12. (For suspension of non-insulated stationary pipe lines; 3/8" to 3".)

L. U-Bolts: MSS Type 24. (For support of heavy loads; 1/2" to 30".)

M. Clips: MSS Type 26. (For support of uninsulated piping not subject to expansion or contraction.)

N. Pipe Saddle Supports: MSS Type 36, including steel pipe base- support and cast-iron floor flange. (To support pipe from floor stanchion, using floor flange to secure stanchion to floor 4" to 36".)

O. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange. (To Type 36 except U-bolt provided for retaining pipe.)

P. Type 19 and 23 shall be torqued in accordance with MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. The C-clamp body shall not be constructed from bent plate.

Q. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.

R. U-Bolts: MSS Type 24. (For support of heavy loads; 1/2" to 30".) Type 24 may be used only on trapeze hanger systems or on fabricated frames.

S. Clips: MSS Type 26. Do not use.

T. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

1. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.
2. Where there are high system temperatures and welding to piping is not desirable, type 35 guides shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.
3. Insulated pipes: Except for type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

U. Pipe Saddle Supports: MSS Type 36, including steel pipe base- support and cast-iron floor flange. (To support pipe from floor stanchion, using floor flange to secure stanchion to floor 4" to 36".)

V. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange. (To Type 36 except U-bolt provided for retaining pipe.)

W. Where type 39 saddle or type 40 shield is permitted for a particular pipe attachment application, the type 39 saddle shall be used on pipe 4 inches and larger.

X. Provide Spring Hangers at all points where hot piping is supported in a way that vertical movement against horizontal suspension is involved. MSS types 48, 49 51 and 53 could be commonly applied. Where sideways restraint is needed use Type 50 support mechanisms or an equivalent. Provide springs of sufficient character to carry n ot less than 125% of the maximum probable load with enough travel length to accommodate 150% of the maximum probable travel at any point of support.

2.2 VERTICAL-PIPING CLAMPS:

A. General: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and

manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

B. Two-Bolt Riser Clamps: MSS Type 8. (For support and steadying of pipe risers; 3/4" to 20". Also supports pipe covering or insulation.)

C. Four-Bolt Riser Clamps: MSS Type 42. (When longer ends are required for riser clamps.)

2.3 HANGER-ROD ATTACHMENTS:

A. General: Except as otherwise indicated, provide factory- fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

B. Steel Turnbuckles: MSS Type 13. (For adjustment up to 6" for heavy loads.)

C. Steel Clevises: MSS Type 14. (For use on high temperature piping installations.)

D. Swivel Turnbuckles: MSS Type 15. (For use with split pipe rings, MSS type 11.)

E. Malleable Iron Sockets: MSS Type 16. (For attaching hanger rod to various types of building attachments.)

2.4 BUILDING ATTACHMENTS AND EMBEDS:

A. General: Except as otherwise indicated, provide factory- fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.

B. Concrete Inserts: MSS Type 18. (For upper attachment for suspending pipe hangers from concrete ceiling.)

C. Top Beam C-Clamp: MSS Type 19. (Use under roof installations with bar joist construction, for attachment to top flange of structural shape.)

D. Side Beam or Channel Clamps: MSS Type 20. (For attachment to bottom flange of beams, channels, or angles.)

E. Center Beam Clamps: MSS Type 21. (For attachment to center of bottom flange of beams.)

F. Welded Beam Attachments: MSS Type 22. (For attachment to bottom of beams where loads are considerable and rod sizes are large.)

G. C-Clamps: MS Type 23. (For attachment to structural shapes.)

H. Top Beam Clamps: MSS Type 25. (For attachment to top of beams when hanger rod is required tangent to edge of flange.)

I. Side Beam Clamps: MSS Type 27. (For attachment to bottom of steel I-beams.)

J. Steel Beam Clamps with Eye Nut: MSS Type 28. (Same as Type 28 with link extensions.)

K. Linked Steel Clamps with Eye Nut: MSS Type 29. (Same as Type 28 with link extensions.)

L. Malleable Beam Clamps: MSS Type 30. (For attachment to structural steel.)

M. Steel Brackets: One of the following for indicated loading:

1. Light Duty: MSS Type 31, to 570 pounds.

2. Medium Duty: MSS Type 32, to 1,500 pounds.

3. Heavy Duty: MSS Type 33, to 3,000 pounds.

N. Side Beam Brackets: MSS Type 34. (For use on sides of steel or wooden beams.)

O. Plate Lugs: MSS Type 57. (For attachment to steel beams where flexibility at the beam is desired.)

P. Horizontal Travelers: MSS Type 58. (For supporting piping systems subject to linear horizontal movements where head room is limited.

Q. Refer to drawings for Unistrut inserts.

2.5 MANUFACTURERS OF HANGERS AND SUPPORTS:

A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:

1. Kin-Line, Inc.
2. Fee & Mason Mfg. Co.; Div. Figgie International
3. ITT Grinnel Corp.
4. B-Line
5. Unistrut

2.6 HIGH HUMIDITY AREAS: Use cadmium plated or galvanized; hangers, strut, angle iron, attachments, rods, nuts, bolts and other accessories in boiler rooms or other high humidity areas.

2.7 OUTSIDE AREAS: Use galvanized hangers, attachments, rods, nuts, bolts and other accessories for all outside areas.

2.8 MISCELLANEOUS MATERIALS:

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration. Use Embeco grout for non-shrink applications.

D. Heavy Duty Steel Trapezes: Fabricate from factory built channel (Unistrut) system and use factory fasteners for channel steel shapes, selected for loads required; weld steel in accordance with AWS standards.

PART III - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

PREPARATION:

B. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

C. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection, and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.2 INSTALLATION OF BUILDING ATTACHMENTS:

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.

1. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the tops of inserts.

3.3 INSTALLATION OF HANGERS AND SUPPORTS:

A. General: Install hangers, supports, clamps and attachments to rigidly support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use

wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by isolating with foam rubber covering or 30 mil insulating tape.

D. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

2. Install supports within 2 feet of non-vertical flex connectors.

E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.

G. Insulated Piping: Do not allow hangers to come in contact with pipe where pipe is specified to be insulated.

H. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

3.4 EQUIPMENT SUPPORTS:

A. Provide concrete housekeeping bases for all floor or grade mounted equipment furnished as part of the work of Division 23. Size bases to extend a minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

3.5 ADJUSTING AND CLEANING:

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments.

B. Support Adjustment: Provide grout under support so as to bring piping and equipment to proper level and elevations.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 230529

SECTION 230548 - MECHANICAL SOUND, VIBRATION AND SEISMIC CONTROL

PART I - GENERAL:

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-23 Mechanical Sound, Vibration and Seismic Control section, and is part of each Division-23 section making reference to mechanical sound, vibration and seismic control specified herein.

C. Division-23 General Mechanical Requirements apply to work of this section.

1.2 SUMMARY: Furnish and install complete seismic restraint and vibration control systems for all work installed under Division 23. Including owner furnished contractor installed equipment. Work to be responsive to the intent of the International Building Code, latest adopted edition, for the respective seismic zone. Site classification D, importance factor of 1.5 and Chapter 13 of ASCE 7.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Engage the services of an independent seismic and vibration control subcontractor who has the technology, experience, computer capabilities and manufactured products to prepare the required computations, shop drawings and special devices to meet the minimum requirements described herein. Select from the following:

1. Amber Booth
2. Kinetics
3. Mason
4. Vibro Acoustics

B. The seismic and vibration control subcontractor shall visit the site during construction at a minimum of two specific periods.

1. When equipment is set in place, prior to placement of seismic restraint devices for the purposes of directing the contractor in properly locating and installing the approved devices.

2. At the completion of the project, prior to final mechanical inspection, for the purpose of verifying the correctness of the seismic restraint and vibration isolation device installation and prepare certification of the seismic vibration-isolation work.

C. The seismic subcontractor shall exercise the quality control for this work and shall include, but not be limited to instructions direct to the Mechanical (Division 23) Contractor concerning:

1. Anchoring of all new mechanical equipment.

2. Vibration mounting of equipment.

3. Equipment base coordination with restraint requirements.

4. Snubbing of equipment.

5. Bracing and anchoring of ductwork piping and conduit.

6. Provision for expansion and vibration of piping.

7. Concrete bases to assure proper mounting of restraints and isolators.

D. The subcontractor shall be responsible for identifying the need for the size and location of steel sole plates and their attachment to structural steel or concrete.

E. The subcontractor shall certify in writing that he has inspected the installation and that all isolation, anchors and seismic restraint materials are installed correctly and functioning properly. Certification shall be provided after all corrective work has been completed.

1.4 SUBMITTALS:

A. Submittal data is required and shall consist of computations, vibration isolation selection, equipment anchors, anchor bolt sizes, supports, seismic restraints, sole plate data, restraint locations and type of restraints.

B. Submittal data shall identify dimensions, load deflection data, center of gravity, standard connections, manufacturer's recommendations, behavior problems including vibrations, thermal expansion, building expansion joints, etc., associated with equipment, ductwork, piping and conduit.

C. Calculations need not be submitted when restraint devices for piping, conduit and ductwork are proposed in accordance with the SMACNA Guidelines for Seismic Restraints.

D. Selection of isolator anchors and restraints shall be clearly made known along with the basis for selection so that proposed systems can be reviewed.

E. Calculations furnished for anchors, anchor bolts, sole plates and other support steel for restraining devices shall be signed and stamped by an engineer licensed in one of the United States.

1.5 REFERENCES:

A. Codes and Standards: (Latest adopted edition)

1. International Building Code
2. NFPA bulletin 90A,
3. UL Standard 181
4. Guidelines for seismic restraint of Mechanical Systems and Plumbing Piping Systems. Published by the Sheet Metal Industry Fund of Los Angeles, California, and the Plumbing and Piping Industry Council, Inc., Los Angeles, California.

PART II - PRODUCTS:

2.1 MATERIALS - PRODUCTS: Restraint devices shall be specially designed to resist seismic forces in all directions.

A. Snubbers: Restraint surfaces which engage under seismic motion shall be cushioned with a resilient elastomer neoprene (bridge bearing neoprene) to protect equipment. Restraints shall allow a maximum of 1/4" before engaging and shall not interfere in normal starting or stopping operation. Housing shall allow for visual inspection to determine clearances during system operation. Restraints shall be field adjustable and be positioned for up to 1/4" clearance both horizontally and vertically. Mountings and snubbers are to be manufactured under a Quality Assurance (QA) Program.

B. Snubbers and Isolator Combination Devices: Combination unitized devices may be used where equipment isolation is required. They shall include the requirements listed for snubbers. The isolation portion shall be stable spring type with combination leveling bolt and equipment fastening device. Base plate shall have adequate means for bolting to structure. The spring assembly shall be removable and shall fit within a welded steel enclosure.

C. Piping, Conduit and Duct Restraints: Restraint materials for exposed installation shall be standard fabricated flat steel, angle rod and channel members.

1. Restraint members shall be bolt connected. Cabling materials and methods shall be used only in chases or concealed ceiling spaces.

PART III - EXECUTION

3.1 SEISMIC RESTRAINT GUIDELINE:

A. Guidelines for SMACNA seismic restraints for conduit, piping and ductwork are to serve as the basis for restraint methods. (Exception - no cabling shall be used in the restraint systems except as noted.)

3.2 SEISMIC RESTRAINT-PIPING AND CONDUIT:

A. General: All piping and conduit shall be protected in all planes by restraints, designed to accommodate thermal movement while at the same time restraining seismic motion. Tanks and vessels connected to piping shall be restrained in the same manner as the piping.

B. Locations of the restraints shall include, but not be limited to:

1. At all drops or risers to equipment connections.

2. At all changes in direction of piping and conduit.

3. At all horizontal runs of pipe and conduit to keep it in alignment and prevent sagging with restraints not to exceed the following:

a. Transverse bracing at 40'-0" O.C. maximum.
b. Longitudinal bracing at 80'-0" O.C. maximum.

4. Provide flexibility in joints where pipes pass through building seismic or expansion joints.

5. On both sides of flexible connectors.

C. Exceptions:

1. Conduit under 2-1/2" size and piping under 1-1/2" size need not be additionally seismically restrained except as follows:

a. Brace all piping and conduit 1-1/4" and larger in mechanical rooms and electrical equipment rooms.

2. Seismic bracing may be omitted:

a. When the top of the pipe is suspended 12" or less from the supporting structure member and the pipe or conduit is suspended by an individual hanger.

b. On all piping 3/4" and smaller.

3.3 SEISMIC RESTRAINT INSULATED PIPING: Where piping is designated to be insulated, the points of support shall be protected by a 360° sheet metal shield. Insert insulation shall be of the same thickness as the adjoining pipe insulation. (Pipe Shields, Inc.)

The sheet metal shield wrapped around the insert shall be of the following lengths and gauge thickness.

PIPE SIZE	SHIELD LENGTH	MINIMUM GAUGE
1/2 - 1-1/2"	4"	20
2 - 6"	6"	20
8 - 10"	9"	16
12 - 18"	12"	16
20 and up	18"	16

3.4 SEISMIC RESTRAINT - DUCTWORK:

A. Ductwork, four feet square and larger in cross sectional area or 26" diameter and larger shall be protected in all places by restraints. Locations shall include, but not be limited to:

1. At all equipment connections.

2. At all duct turns and duct run ends (transverse bracing).
3. Transverse bracing to occur 30'-0" O.C. maximum. Rectangular ducts 61" and larger in either direction may be braced at 32'-0" O.C.

4. Longitudinal bracing shall occur at 60'-0" O.C. maximum.

B. A group of ducts may be combined in a larger size frame using the overall dimensions with maximum weight for selection of restraint members.

C. No bracing is required if the top of the duct is suspended 12" or less from supporting member and attached at the top of the duct as well as sides and bottom.

3.5 VIBRATION ISOLATION:

A. General: Furnish and install devices to isolate moving equipment from the structure. Review isolation furnished with factory package equipment, require conformance with project criteria.

B. Basic Criteria: Vibration isolation devices which have natural frequencies approximately 1/10 that of the related driving frequency.

C. Equipment to Include:

1. Package air handling unit.

2. Condensing Unit.

3. Heat Pump Unit.

D. Field Verify: All required devices and installation.

3.6 VIBRATION ISOLATION - DUCTWORK AND PIPING:

A. Furnish and install devices to isolate all piping and ductwork from other moving equipment. Provide flex connections, spring hangers, grooved joint couplings for pipe, etc., as required.

END OF SECTION 230548

SECTION 230553 - MECHANICAL IDENTIFICATION

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic Mechanical Materials and Methods section apply to work of this section.

1.2 SUMMARY:

A. Label all plumbing, heating, air conditioning, automatic temperature control equipment (excluding thermostats and relays), and distribution systems. Also label all electrical switches and starters for all mechanical equipment. Label all fire dampers, fire smoke dampers, smoke damper access doors.

PART II - GENERAL MECHANICAL MATERIALS AND METHODS

2.1 EQUIPMENT AND DUCT IDENTIFICATION:

A. Equipment:

1. Use the same identification number and name as that shown on the drawings or in these specifications. Make equipment nameplates of black face Formica with white engraved lettering 3/16" high or larger, attached securely.

2. Include the following information on equipment nameplates where applicable:

Identification name.
Identification number.
Capacity specified.
Actual capacity.
Area or zone served.

Note operating conditions, including head or static pressure, RPM, motor horsepower at design conditions, area or zone served, name of lubricant, frequency of lubrication.

B. Valve Identification:

1. For all valves, regardless of size, provide brass tags at least 1-1/4" by 3" in size and 0.051 inches thick. Use engraved lettering at least 1/8" high. Identify each valve on the drawing separately, and with valve tags matching the drawing identification.

2. Provide valve tags which include the following minimum information:

a. Normal Position
b. Duty

3. Make a schedule of all tagged valves, included in O & M Manuals.

4. Connect valve tags to valve stems with brass chain.

C. Color code all accessible duct and piping and identify with wording and arrows every 50 feet, at each riser, at each junction, at each access door, and where required to easily identify the medium transported.

D. Identify duct and piping systems by:

1. Lettering color, and

2. Flow Direction Arrow.

3. Identifying lettering shall be painted or stenciled on duct or pipe. Self-adhesive or glue-on type labels are acceptable. Letters shall be 2" high for duct and for 3" or larger piping, 1" high for 1-1/4" to 2-1/2" pipe, and 1/2" high for 1" pipe and smaller.

4. Arrows to indicate direction of flow shall be painted or stenciled on the duct or pipe in the same color as the lettering. The arrow shall point away from the lettering. On duct and 3" or larger piping, the “shaft” of the arrow shall be 2" long and 1" wide. Smaller piping, 2-1/2" or less, shall have arrows with a shaft 1/2" wide and 2" long. Use a double-headed arrow if the flow can be in either direction.

5. Piping and duct shall be identified with the following colors:

6. Label existing high temperature water piping.

Medium in Pipe or Duct	Banding Color	Identifying Lettering	Abbreviation and Lettering Color
Drain		Drain	Black
Supply Air Duct		Supply Air Duct	(Unit Served) - Black
Return Air Duct		Return Air Duct	(Unit Served) - Black
Exhaust Air Duct		Exhaust Air Duct	(Unit Served) - Black

2.2 PANEL IDENTIFICATION:

A. Provide all panel devices on panel faces with engraved black face Formica with white engraved lettering labels.

B. Provide all internal panel components with engraved black face Formica labels with white engraved lettering. Fasten label beneath each device.

C. Numerically or alphabetically code all panel wiring and tubing.

END OF SECTION 230553

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SECTION 230593 - SYSTEM COMMISSIONING, TESTING AND BALANCING

PART I - GENERAL

1.1 GENERAL CONDITIONS:

A. The work of this section shall be subject to the requirements of the General Conditions of this contract, the General Mechanical Requirements, General Electrical Requirements and other sections where this work shares a responsibility.

B. System commissioning and startup of the mechanical systems shall be the responsibility of the Mechanical Contractor and his subcontractors with the participation of the Electrical Contractor related to electrical work and the General Contractor related to general construction items.

C. Testing and Balancing shall be the responsibility of the Mechanical Contractor under the direction of the General Contractor with the full participation of all the mechanical and electrical trades employed on the project and shall include the participation of an independent testing and balance contractor to coordinate all elements of the work and to perform special technical services outlined herein.

1.2 SYSTEM COMMISSIONING - EXTENT OF WORK:

A. The work required by this section includes but is not necessarily limited to the following:

1. The pre-startup inspection of all systems and subsequent correction of any incorrect items.

2. The initial first run inspections.

3. System operations inspection.

B. The intent of this work is to provide proper installation, startup, service and operation of the mechanical systems in preparation for system balancing.

C. Repair, replacement, or adjustment of each item shall be performed by the installation contractor.

D. Involves all new construction and those elements of existing construction which are affected by this project.

1.3 TESTING AND BALANCING - EXTENT OF WORK:

A. This work incorporates a confirming checkout of construction work, an individual component activation and an overall system activation into one work program which shall serve as the transition period from the Contractor's job to Owner's facility.

B. The TAB Contractor shall be skilled in the operation and manipulation of systems and in the direction of parties involved in the work.

C. Conduct and participate in the startup and shakedown of all mechanical systems installed and modified in this contract; test adjust and balance these systems to obtain optimum performance at a level which minimizes the required energy input, prepare and submit a complete report of work done and the final system condition obtained, participate in the instruction of Owner's personnel in the proper operation of systems and equipment.

D. Involves all new construction and those elements of existing construction which are affected by this project.

1.4 QUALIFICATIONS OF SYSTEM COMMISSIONING AND TAB TEAM:

A. Representatives of the General Contractor, Mechanical Contractor, etc., and Electrical Contractor shall be available daily through the commissioning and adjustment period. These men shall be experienced journeymen with prior experience in system operation and with specific experience on the construction of this project.

B. Balancing shall be done by an independent firm specializing in this work. A definition of independent shall mean the firm is not associated with any engineering, contracting, or manufacturing firm and derives its income solely from testing, adjusting, and balancing mechanical systems. Approved firms to do this work are Barnett, Inc., Payson, Utah and BTC Services, Salt Lake City, Utah.

C. The balancing work including air and hydronic portions shall be performed by the same firm having total responsibility for the final testing, adjusting, and balancing of the entire system. A principal of the firm shall be directly involved in the project.

D. The independent testing and balancing firm shall furnish all necessary tools, scaffolding and ladders that are required and shall provide all required instruments, take all readings and make all necessary adjustments.

E. After all tests and adjustments are made a detailed written report shall be prepared and submitted for review and shall bear the signature of the professional supervising the work. Final acceptance of this project will not be made until a complete and satisfactory report is received. Furnish two copies of the report.

PART II - EXECUTION, SYSTEM COMMISSIONING

2.1 PRE-STARTUP INSPECTION:

A. The pre-startup inspection of all systems shall provide for verifying that each piece of equipment is properly installed and prepared for startup.

B. All pertinent items shall be checked, including but not necessarily limited to the following:

1. Removal of shipping stops.

2. Vibration isolators properly aligned and adjusted.

3. Flexible connections properly aligned.

4. All systems properly filled.

5. Filters in place and seal provided around edges.

6. Relocated fire and smoke damper properly installed and linked. Access doors are in place for every damper.

7. All test stations and measuring devices installed.

8. Initial lubrication of equipment is complete.

9. Filters are clean.

10. The control system is in operation.

11. All interlocks are wired and verified.

12. All controls have been connected and verified.

13. All dampers and operators are properly installed and operating.

14. All ductwork is installed and connected.

15. All other items necessary to provide for proper startup.

2.2 FIRST RUN INSPECTION:

A. Recheck all items outlined in pre-startup inspection to insure proper operation.

B. Check the following items:

1. Excessive vibration or noise.
2. Loose components.
3. Initial control settings.
4. Motor amperages.
5. Heat buildup in motors, bearings, etc.
6. The control system is properly calibrated and functioning as required.

C. Correct all items which are not operating properly.

2.3 SYSTEM OPERATION INSPECTION:

A. Observe mechanical systems under operating conditions for sufficient time to insure proper operation under varying conditions, such as day-night and heating-cooling.

1. Periodically check the following items:

2. Filters.

3. Visual checks of air flow for "best guess" settings for preparation for system air balancing under section applying.

4. Control operation, on-off sequences, system cycling, etc.

5. Cleaning of excessive oil or grease.

6. Dampers close tightly.

7. System leaks.

8. All other items pertaining to the proper operation of the mechanical system whether specifically listed or not.

PART III - EXECUTION - TESTING AND BALANCING

3.1 TOTAL MECHANICAL SYSTEM BALANCE:

A. The mechanical systems balance involves elements of the work of the General Contractor, the Electrical Contractor, the Mechanical Contractor, the Sheet Metal Contractor, and the Controls Contractor. Total system balance requires that all elements be not only individually correct, but also correct as a composite system. Therefore, participation of all parties shall be required in the test and balance procedure.

B. Prior to beginning work, a written description of the anticipated sequence of action shall be submitted to the Architect/Owner for review and comment.

C. The testing and balance specialist shall review the contract drawings during the bid period and shall advise the Architect of any modifications to the layout which may be needed to facilitate the balance procedure. Modifications will be incorporated into the contract by Addendum during the bidding period.

D. The test and balance specialist shall visit the project from time to time during the rough installation making a thorough inspection of those items which will affect his subsequent work. He shall advise the Contractor in writing with a copy to the Architect of any work required by the contract which is not being performed adequately. This is in addition to the regular inspection efforts of the Architect and Engineer. Particularly note needed dampers, access doors, belts and drives, diffuser styles and filters, etc.

3.2 AIR SYSTEMS BALANCE:

A. Before any adjustments are made, check the systems for such items as dirty filters, duct leakage, filter leakage, damper leakage, equipment vibrations, correct damper operations, etc. Adjust all VAV and CVAV boxes, registers, diffusers, etc., to deliver design air quantities within +5%. Individual air outlets, when one of three or more serve a space may have a tolerance of 10 percent from the average. Design static pressure is based on filters approximately 50% loaded with dirt. Pressure drop across filters during balancing shall be simulated to that condition. After balancing is completed check motor amperage with the filters clean.

B. Adjust supply, exhaust and recirculation air systems towards air quantities shown on drawings. Establish a proper relationship between supply and exhaust. Follow proportional balance procedures outlined by AABC and/or SMACNA for such work.

C. The distribution system shall be further adjusted to obtain uniform space temperatures free from objectionable drafts and noise within the capabilities of the system.

D. Exchange belts where applicable as needed to adjust the RPM of all fans so they handle

specified air quantity.

E. Verify the function of all Variable Frequency Drives and related controls.

3.3 MAJOR EQUIPMENT: The Testing and Balancing Contractor shall work with the Controls Contractor and Electrician in placing heat pumps, condensing units, fans and other major equipment in operation. The factory representative of the equipment manufacturer shall also participate in a team effort to place the system(s) in operation, adapt to all anticipated operating modes and adjust as required to obtain correct operation. The Design Engineer and the Owner's Representative shall witness the final operating sequences.

3.4 CONTROL SYSTEMS: The Testing and Balancing Contractor shall go through the entire revised control system with the Controls Contractor verifying proper operation of each device and the proper function of each system. Certify such effort in the report.

3.5 MISCELLANEOUS:

A. Observe and note all furnished thermal overload protection in the data sheets. If thermal overload protection is incorrect, the trade which furnished the overload devices shall furnish and install the correct size overload protection devices. It shall be the responsibility of the balancing firm to confirm that proper overload protection has been installed at the completion of the job.

B. Measure and set any special conditions such as minimum air quantities; coordinate outside air, return air and relief air damper operation; check and adjust outside and return air intakes so that the system will deliver substantially the same volume on either; make tests and record data as required in "REPORT" below.

C. All balancing devices, i.e. dampers, shall be clearly marked as to the final balanced position. Plug all test holes, replace access doors and belt guards.

D. Upon request, based on perceived need, make 24-hour space temperature recordings. Any required rebalance of the system shall be performed without additional cost.

E. Upon request, a representative of the balancing firm performing the work shall demonstrate fluid flow quantities shown in the report by reading back outlets or terminals selected specifically or at random by the Design Engineer. It is understood that the operating mode of the system shall be the same for read-back as it was during balancing.

3.6 REPORT:

A. Provide a bound report in four copies containing a general information sheet listing instruments used, method of balancing, altitude correction, and manufacturer's grille, register and diffuser data.

B. Provide equipment data sheets listing make, size, serial number, rating, etc. of all mechanical equipment including fans, air controllers, motors, starters, and drives. Operating data shall include rotational speed, inlet and outlet pressures, pressure drop across filters, coils, and other system components, and measured motor current and voltage.

C. Balancing data sheets shall indicate the required and actual CFM of all supply, return and

exhaust outlets or inlets, and be totaled and summarized by systems.

D. Include a reduced set of contract drawings with outlets marked for easy identification of the designation used in the data sheets.

E. Note any abnormal or notable conditions not covered in the above.

F. Keep a daily log of all work performed, with a list of work scheduled for each day and the workers on the job.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections apply to work of this section.

B. Division-23, Section 230000 - General Mechanical Requirements applies to work of this section.

1.2 SUMMARY:

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules as required by the current International Energy Code, and by requirements of this section. Use no asbestos in this work. Include restorations of insulations of damaged work including repair of damaged existing insulation due to new work.

B. Types of mechanical insulation specified in this section include the following:

1. Ductwork System Insulation:

a. Fiberglass.
b. Rigid Flexible Wrap.

C. Refer to Division-23 section "Supports and Anchors" for protection saddles, protection shields, and thermal hanger shields.

D. Refer to Division-23 section "Ductwork" for duct linings.

E. Refer to Division-23 section "System Identification" for installation of identification devices for piping, ductwork, and equipment.

1.3 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in the manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer’s Qualifications: Firm with at least 5 years’ successful installation experience on projects with mechanical insulations similar to that required for this project.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in the maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard ratings of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART II - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide mechanical insulation materials of one of the following (except as noted):

1. Armstrong World Industries, Inc.
2. Babcock and Wilcox Co., Insulating Products Div.
3. CertainTeed Corp.
4. Knauf Fiber Glass GmbH.
5. Manville Products Corp.
6. Owens-Corning Fiberglass Corp.
7. Pittsburgh Corning Corp.
8. Rubatex Corp.

2.2 DUCTWORK INSULATION MATERIALS:

A. Rigid Fiberglass Ductwork Insulation: ASTM C 612, Class 1. Class 1 - 400^{o}F (204^{o}C); Class 2 - 400^{o}F (204^{o}C); Class 3 - 850^{o}F (454^{o}C); Class 4 - 1000^{o}F (538^{o}C); Class 5 - 1800^{o}F (982^{o}C); Class 1 - 10 lbs/ft^{3}; Class 2, 3 and 4 - 12 lbs/ft^{3}; class 5 - 20 lbs/ft^{3}.

B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, Class B-4. Type 1 - resilient, flexible; Class B-1 - 0.65 lbs/ft^{3}; Class B-2 - 0.75 lbs/ft^{3}; Class B-3 - 1.0 lbs/ft^{3}; Class B-4 - 1.5 lbs/ft^{3}; Class B-5 - 2.0 lbs/ft3; Class B-6 - 3.0 lbs/ft^{3}; Type II - flexible; Class F-1 - 4.5 lbs/ft^{3}; Type III - semirigid; Class F-2 - 4.5 lbs/ft^{3}.

C. Jackets for Ductwork Insulation: ASTM C 921, Type I for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.

D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

E. Ductwork Insulation Compounds: Provide cement, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART III - EXECUTION

3.1 GENERAL:

A. Fire and smoke hazard for a complete insulation system shall not exceed:

1. Flame spread - 25
2. Fuel contribution - 50
3. Smoke development - 50

B. Hangers shall not contact duct where duct is specified to be insulated.

3.2 INSPECTION:

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.3 DUCTWORK SYSTEM INSULATION:

A. Dual Temperature Ductwork:

1. Application Requirements: Insulate the following ductwork:

a. Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.

b. HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet. Insulate neck and bells of supply diffusers.

c. HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet: except omit insulation on return ductwork located in return air ceiling plenums.

d. HVAC plenums and unit housings not pre-insulated at factory or lined.

e. HVAC relief air plenums and ductwork.

2. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:

a. Rigid fiberglass: Class 1, 1-1/2" thick, increase thickness to 2" in machine, fan and equipment rooms. Insulation shall be minimum R-6.

b. 1-1/2 lb/ft^3 or 2 lb/ft^3 density, 2” thick,” (as the specification currently states, the insulation must be a minimum R-6).

B. High and Medium Velocity Duct: Insulate externally with type 1, class B-4 (1-1/2 lb/ft^3

density) 2" thick fiberglass faced duct wrap with factory applied foil scrim Kraft facing U.L. 723 label. The insulation shall be minimum R-6.

C. Duct Insulations:

1. Wrap insulation snugly on the ductwork such that maximum thickness is maintained. Butt all circumferential joints and overlap longitudinal joints a minimum of 2". Adhere insulation with 4" strips of Insulation Bonding Adhesive, at 8" on center.

2. On circumferential joints, staple the 2" flange of the facing with 9/16" flare-door staples on 6" centers and taped with minimum 3" wide foil reinforcing Kraft tape. Tape all pin penetrations or punctures in the facing.

3.4 INSTALLATION OF DUCTWORK INSULATION:

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage.

E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

F. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

G. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

3.5 EXISTING INSULATION REPAIR:

A. Repair damaged sections of mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.6 PROTECTION AND REPLACEMENT:

A. Replace damaged insulation, which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during construction period to avoid damage and deterioration.

END OF SECTION 230700

SECTION 230719 - REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install insulation on above-ground refrigerant piping and fittings as described in Contract Documents.

B. Related Sections
   1. Section 232300 - Refrigerant Piping Systems

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flexible Foamed Pipe Insulation
   1. Thickness -
      a. 1/2 inch for one inch outside diameter and smaller pipe.
      b. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.
      c. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of 1/2 inch.)
      d. One inch sheet for fittings as recommended by Manufacturer.
   2. Approved Products -
      a. AP Armaflex by Armacell
      b. Rubatex

B. Joint Sealer
   1. Approved Products -
      a. Armaflex 520 by Armacell
      b. BFG Construction Adhesive No. 105
      c. Rubatex R-373

C. Insulation Tape
   1. Approved Products -
      a. Armaflex AP Tape by Armacell
      b. R-180-FS Tape by Rubatex

D. Exterior Finish
   1. Approved Products -
      a. WB Armaflex Finish by Armacell
      b. Protective Coating 67x944 by Rubatex

2.2 MANUFACTURERS

A. Armacell, Mebane, NC (800) 232-3341 www.armaflex.com
B. BFG Industries, West Columbia, SC (800) 845-2220 or (803) 796-1380
C. Rubatex, Roanoke, VA 782-2839 or (540) 561-6000 www.rbxcorp.com

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.
a. Insulate flexible pipe connectors.
b. Insulate thermal expansion valves with insulating tape.
c. Insulate fittings with sheet insulation and as recommended by Manufacturer.
2. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.
3. Do not install insulation on lines through clamp assembly of pipe support. Butt insulation up against sides of clamp assembly.
4. Provide 6 inch long, 20 ga galvanized steel sleeve around pipe insulation at each support. Extend insulation through pipe support clamps.
5. Stagger joints on layered insulation. Seal joints in insulation.
6. Install insulation exposed outside building so 'slit' joint seams are placed on bottom of pipe.
7. Paint exterior exposed insulation with two coats of specified exterior finish.

B. System Requirements
1. Condensing Units - Install insulation on above-ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve.
2. Split System Heat Pump Units - Install insulation on above-ground refrigerant liquid and suction piping and fittings.

END OF SECTION 230719

9+SECTION 230900 - MECHANICAL CONTROL SYSTEMS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 General Mechanical Requirements sections apply to work of this section.

1.2 SUMMARY:

A. Extent of control systems work required by this section is indicated on drawings and schedules, and by requirements of these control related sections.

1. See following sections for types of Control Systems included as a part of this section.
2. Section 230923 – Direct Digital Control Systems
3. Section 230933 – Electric Control Systems
4. Control sequences are specified in this section under: "Sequence of Operation".

B. Refer to other Division-23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems.

C. Refer to Division-26 sections for the following work.

1. Power supply wiring from power source to power connection on controls and/or unit control panels. Includes starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

2. Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices.

a. Interlock wiring specified as factory-installed is work of this section.

D. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:

1. Control wiring between field-installed equipment, controls, indicating devices, and unit control panels.

2. 120 volt service required by control systems.

E. Participate in "System Commissioning, Testing and Balancing".

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in the manufacture of electric control equipment, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. INSTALLER'S QUALIFICATIONS: Firms and workmen specializing and experienced in electric control system installations for not less than 5 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions.

B. Shop Drawings: Submit shop drawings for each control system, containing the following information:

1. Schematic flow diagram of system showing fans, coils, dampers, and control devices, etc.

2. Label each control device with setting or adjustable range of control.

3. Indicate all required electrical wiring. Clearly differentiate between portions of work that are factory-installed and portions to be field-installed. Note contract responsibility to provide complete system regardless of delegation. Completely interface with and show existing installation in the existing building.

4. Provide details of faces of control panels, including controls, instruments, and labeling.

5. Include verbal written description of sequence of operation. Confirm correct function of proposed sequences.

C. Samples: Submit sample of each type of proposed thermostat cover.

D. Maintenance Data: Submit maintenance instructions and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Section 230100.

1.5 REFERENCES:

A. Codes and Standards:

1. Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.

2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.

3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

4. Comply with NEPA 70, "National Electric Code" for all electrical installation.

1.6 DELIVERY, STORAGE, AND HANDLING: Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protected from weather.

1.7 INSTRUCTION OF OWNER'S PERSONNEL: (See Section 230000)

A. The purpose is to provide a transition of the systems from the Contractor to the Owner, leaving the Owner's personnel familiar with and well qualified to operate and maintain the systems.

B. Instruction to cover purpose and function of each system and its components, to show proper operating technique, to show proper maintenance technique.

C. Prepare an outline of information to be conveyed, list materials available for reference. Submit to Architect along with a proposed schedule of instruction. Schedule to allow individual time for each trade and each system.

D. Convey information in formal classroom session. Teachers shall include qualified contractor personnel and sales representatives for each major piece of equipment. Go from the classroom to the actual location to graphically illustrate concepts discussed.

1.8 WARRANTIES:

A. As part of the overall project warranty, furnish individual manufacturer warranties for each piece of equipment for a period of not less than one year from date of Owner's beneficial use (substantial completion).

B. Warrant the overall assembly of equipment, materials and labor comprising these systems.

1.9 CLEANING AND LUBRICATION: All modified instruments, control panel and control piping shall be thoroughly cleaned before final acceptance. Provide lubrication for all furnished equipment.

1.10 TESTING AND ADJUSTING OF SYSTEM:

A. During the system commissioning, testing, and balancing of the revised building systems, have a controls representative(s) present and available to interpret and adjust controls as needed. Demonstrate and report the integrity and accuracy of each function and control point.

B. At the termination of the testing period, the Controls representative shall spend one working day instructing the Owner's operating personnel in the control system operation, and one working day checking the modified system for day-night and manual override with the Owner's operating personnel on each air system. A complete operating booklet shall be provided and used during the training period. Schedule this training with the Owner and Mechanical Contractor.

1. Since system performance is partly a function of climatic conditions, the Controls contractor shall be available during the changing seasons of the warranty period to make further adjustments and modifications if required. A final complete check of all systems shall be made at the conclusion of the one year warranty period.

PART II - PRODUCTS

2.1 CONTROL CABINETS: If a new control cabinet is required, furnish stamped steel with hinged door and locking latch control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all components, numerically code all piping and wiring. Terminate all wiring at terminal blocks. Provide engraved plastic labels for all panel face devices.

A. Provide with surge suppressor - one per panel.

B. Provide with 120/60/1 outlet - one per panel.

C. Provide with fuse - quantity as required.

D. Provide with transformer, 120/24 VAC, quantity as required.

E. Provide RS-232 service trunk from main panel into each ATC panel for "Laptop" computer access.

2.2 DAMPERS:

A. Provide electric damper actuators of proper size, so that the actuators will operate against the static pressure of the systems. Provide each actuator with a bracket for attaching to ductwork, building structure or equivalent. Damper actuators in plenums shall be mounted on damper frames. Do not install actuators in ducts. Modulating actuators shall be provided with integral mechanical stops for both minimum and maximum stop.

B. Control Dampers are specified in Section 233300. They are furnished and installed by the Mechanical Contractor.

PART III - CONTROL SEQUENCES

3.1 GENERAL:

A. Provide control systems to manage and manipulate mechanical equipment in a functional and energy conserving way.

B. Provide control panel in the AHU-9510 fan room, with terminal block connections for interface of air handling unit, heat pump, etc.

C. Set up separate control loop for AHU-9510 fan system.

3.2 CENTRAL CONTROL AND MONITORING SYSTEM:

A. Existing Central Control Units provide for overall control and monitoring of the Building System.

B. The new DDC panel shall also provide programmable time clock functions, optimum start, and signals to existing ATC panels and report space temperature and condition of air handling system AHU-9510.

C. Locate new DDC panel in mechanical room indicated or as directed in the field.

3.3 VARIABLE VOLUME SUPPLY FAN (SF-9510) STATIC PRESSURE CONTROL SEQUENCE:

A. In automatic mode, the supply fan VFD starts via the DDC system, all safeties satisfied. In “Hand”, the supply fan will run when all safeties are satisfied.

B. Control the speed of the supply fan through the duct static pressure sensor to maintain the far end duct static pressure set point at approximately 0.5" w.c. Locate the duct static pressure sensor upstream of the most remote terminal box on the system. The duct static pressure sensor sends a signal to the DDC system. The DDC controller will provide a 4-20 ma input signal to the supply fan variable speed drive. See Specifications under Section 230513 related to the variable speed drive.

C. Interlock the units outside air damper to close and the unit’s return air damper to open when the supply fan is off or during unoccupied mode.

D. Disable the respective heat pump to the unit’s cooling coil when the unit’s supply fan is off or during unoccupied mode.

E. Energize the electric duct heater on low heating stage when each unit’s supply fan wall is off or during unoccupied mode.

F. During occupied mode, the units outside air damper opens at least to minimum position when the supply fan runs.

G. Set up the system so that the supply fan speed can also be set and adjusted manually.

3.4 VARIABLE VOLUME FAN SYSTEM TEMPERATURE CONTROL (SF-9510, HP-4, EHC-1):

A. The DDC system shall control the system temperature.

B. The required makeup air overridden with maximum allowable VOC and CO_2 levels set the amount of minimum outside air required for the system. This shall be set to maintain a positive pressure in respect to the outside. The economizer control for the system shall override the minimum outside air when outside conditions allow for free cooling. The return air damper shall track the outside air damper.

C. A control loop sensing the discharge air temperature for the unit will enable the related unit heat pump, economizer dampers or electric duct heater to maintain a discharge temperature set point of 55°F (adjustable). Provide a discharge temperature sequence for the air handling unit per local energy code which resets the discharge temperature set point higher if the respective worst case VAV box cooling demand is satisfied.

D. When the outside air temperature is favorable operate the unit in an economizer cycle by modulating the return air and outside air dampers to maintain a mixed air temperature of 55°F (adj.), optimized for minimum mechanical cooling. Reset the low limit along with the heat pump to use outside air for cooling. Once the outside air temperature exceeds 75°F (adj.), the outside air dampers shall close to minimum position.

E. If the discharge air temperature setpoint for the unit cannot be met using outside air, the unit's heat pump shall be enabled to run in cooling mode to provide cooling.

F. If the discharge air temperature for the unit falls below 55°F (adj.) due to minimum outside air requirements, the heat pump shall be enabled to run in heating mode to maintain the discharge air temperature of 55°F (adj.) set point. When the heat pump can no longer maintain the minimum discharge air temperature setpoint of 55°F, the electric duct heater shall be staged on as needed to provide additional supplemental heating.

3.5 BUILDING STATIC PRESSURE CONTROL SEQUENCE (EF-9534):

A. The existing relief fan shall be controlled by its respective variable frequency drive through the central automation system.

B. In auto, the existing relief fan cannot run if the respective supply fan is off. In hand or bypass, the relief fan will run. The relief damper shall be interlocked with its respective relief fan to open when the fan runs.

C. The existing differential pressure sensor will send a signal to the central automation system. The differential pressure sensor shall be set to maintain a 0.03" (adj.) positive space pressure related to outside.

D. When the existing space differential pressure rises above set point, the existing relief fan shall be staged on as needed to maintain the space differential set point. First the relief fan damper opens and then the relief fan ramps up in speed to maintain the local space differential pressure set point. This process continues until the relief fan is operating at full speed as needed to maintain the local space differential pressure set point.

3.6 NIGHT SET BACK CONTROL SEQUENCE:

A. The building DDC system has air handling system AHU-9510 off during unoccupied hours.

B. Should the unoccupied temperature drop to 68°F (adj.), the space sensor(s) activate air handling system AHU-9510 ’s supply fan and heat pump HP-4 then the electric duct heater EHC-1 until the temperature rises to 68°F.

3.7 MINIMUM OUTSIDE AIR:

A. For the air handling system AHU-9510, the outside air damper(s) modulate open to minimum position as needed to lower the CO_2 and volatile organic concentration levels in their respective areas below set point.

3.8 CO_2 AND VOC MONITORING:

A. Air quality sensors mounted in the air handling unit AHU-9510’s return air opening monitor the average level of carbon dioxide and volatile organic concentration levels in the respective occupied space and sends a signal to the DDC system to modulate, the units outside air damper(s) to keep these levels below the maximums allowed.

3.9 EXISTING ROOM/SPACE TEMPERATURE:

A. VAV COOLING ONLY:

1. Each existing room/space VAV cooling only box is provided with a VAV box inlet cross flow velocity/temperature sensor and outlet temperature sensor.

2. Each existing room/space VAV cooling only box is controlled by a DDC controller fed through the central control panel.

3. When the room/space temperature is above the set point of the unit controller as sensed by the existing space sensor, the VAV box will be open.

4. As the room/space temperature approaches set point, the cooling VAV box modulates to its minimum which shall be automatically adjustable and set as called for on the drawings.

B. CV COOLING ONLY:

1. Each existing room/space CV cooling only box is provided with a CV box inlet cross flow velocity/temperature sensor and outlet temperature sensor.

2. Each existing room/space CV cooling only box is controlled by a DDC controller fed through the central control panel.

3. When the room/space temperature is above the set point of the unit controller as sensed by the existing space sensor, the CV box will be open.

4. When the room/space temperature approaches set point, the cooling CV box closes.

3.10 EXISTING IN-LINE EXHAUST FAN (EF-9511)

A. The existing in-line exhaust fan starts via its hand-off-auto switch.

B. In the hand mode, the in-line exhaust fan runs continuously.

C. In the auto mode, the DDC system enables the existing in-line exhaust fan to run continuously during occupied hours when air handler AHU-9510 is running, based on a signal from the built in time clock.

3.11 SMOKE/FIRE DAMPERS:

A. When the fire alarm goes off, every smoke/fire damper closes. When the fire alarm shuts off, they open.

B. The damper motors are electric.

END OF SECTION 230900

SECTION 230923 - DIRECT DIGITAL CONTROL SYSTEMS (DDC)

PART I - GENERAL:

1.1 RELATED DOCUMENTS: See Section 230900.

1.2 DESCRIPTION OF WORK:

A. The Building Automation System (BAS) Contractor shall connect into the existing building automation system.

B. All new components shall be able to integrate with the existing system.

C. All new materials and equipment used shall be standard components, regularly manufactured with standard part numbers and owner’s manuals for this and/or other systems. One of a kind, third party or custom integrations devices designed especially for this project will not be allowed.

D. This work incorporates a confirming checkout of construction work, individual component activation and overall system activation into one work program which shall serve as the transition period from the Contractor's job to Owner's facility.

E. The TAB Contractor shall be skilled in the operation and manipulation of systems and in the direction of parties involved in the work.

F. To include all components, materials and installation covered by Section 230933, Electric Control Systems and to be fully integrated with the same.

G. To include all control wiring initiating with power from the distribution panel(s) at line voltage (provide circuit breaker) and extending to transformers, devices, components, etc. which comprise a part of the system.

1.3 QUALITY ASSURANCE: See Section 230900.

A. All new components shall be compatible with the existing Alerton system.

B. The modified system shall be furnished, engineered, and installed by the manufacturers' locally authorized representative. The controls contractor shall have factory-trained technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

C. At the time of bid, all BAS Application Specific Controllers and Programmable Equipment Controllers shall be listed as follows:

1. Underwriters Laboratory, UL 916
2. FCC Regulation, Part 15, Class B

1.4 SUBMITTALS: See Section 230900.

1.5 DELIVERY, STORAGE AND HANDLING: See Section 230900.

1.6 INSTRUCTION OF THE OWNER'S PERSONNEL: See Section 230900.

1.7 WARRANTIES: See Section 230900.

1.8 CLEANING AND LUBRICATION: See Section 230900.

1.9 TESTING AND ADJUSTING OF SYSTEM: See Section 230900.

PART II - PRODUCTS

2.1 CONTROL CABINETS: See Section 230900.

A. Panel mounts all new controllers or expansion modules and devices other than remote sensors and operators. Provide permanent labels, terminal blocks, etc.

B. POWER SUPPLY:

1. Furnish complete power supply for all box controllers at appropriate voltage and in adequate capacity. Provide multiple power supply devices, mount conveniently in custodial closets or spaces as directed. Load power supply units to no more than 70 percent of nameplate capacity.

2. Run all power wiring in conduit, neatly arranged and coordinated with other trades.

3. Group boxes served by each power supply unit in proximity, provide permanent mounted schedule of boxes served by each power supply.

C. COMMUNICATIONS CONDUCTORS:

1. Connect relocated terminal box controller back to the existing Central Direct Digital master controller with required conductors) shielded cable common conduit with AC voltage or inductive loads. All in accordance with National Electric Code, conductors in conduit (3/4" minimum).

D. CONTROL WIRING:

1. All control wiring shall be installed in conduit per National Electric Code. The installation shall be square with the walls of the buildings.

2. Number and code all wiring.

2.2 DAMPERS: See Section 233300.

2.3 GLOBAL CONTROLLER (ACM).

A. Utilize existing in place:

2.4 AIR HANDLER APPLICATION CONTROLLERS

A. Provide an Alerton VIP-363 with necessary expansion modules for each air handler. All controllers shall interface to the building controller through either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and a self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. The programming tool shall be resident on the operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. BACnet Conformance:

1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.

2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented, and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000-ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position. The position of each HOA switch shall be available system wide as a BACnet object property.

D. All program sequences shall be stored on board the application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by the controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and the system shall support display of all information in floating-point nomenclature at operator's terminal.

E. The programming of the application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. The application controller shall be programmed using programming tools as described in the operator's terminal section.

F. Schedules:

1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time clock on board with battery backup to maintain time through power loss.

G. Logging Capabilities:

1. Controller shall support a minimum of 50 trend logs. Any object in the controller (real or calculated) may be logged. Sample time intervals shall be adjustable at the operator's workstation.

2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

H. Alarm Generation:

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.

2. Alarm logs shall be provided for alarm viewing. Logs may be viewed on-site at the operator's terminal or off-site using remote communications.

3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

2.5 EXPANDABLE CENTRAL PLANT APPLICATION CONTROLLERS

A. General:

1. Expandable application controller shall be capable of providing control strategies for the system based on information from any or connected inputs. The program that implements these strategies shall be completely flexible and user definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site though simple download are not acceptable. Changing global strategies using firmware changes is also unacceptable. Program execution of controller shall be a minimum of once per second.

    a. Programming shall be object-oriented using control program blocks. Controller shall support a minimum of 500 Analog Values and 500 Binary Values. Each analog and binary value shall support standard BACnet priority arrays. The programming tool shall be provided with a system and shall be the same tool that is used to program the building controller. Flowcharts shall be generated and automatically downloaded to controller. No re-entry of database information shall be necessary.

2. Provide means to graphically view inputs and outputs on each program block in real-time as program is executing. This function may be performed using the operator's terminal or field computer.

3. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall be a field-replaceable (non-rechargeable) lithium type. Unused battery life shall be 10 years.

4. The onboard, battery-backed real-time clock shall support schedule operations and trend logs.

5. Global control algorithms and automated control functions shall execute using a 32-bit processor.

6. Controller shall include both onboard 10Base-T/100Base-TX Ethernet BACnet communication over UTP and shall include BACnet IP communication. In addition, the controller shall include BACnet Point-to-Point (PTP) connection port.

7. The base unit of the controller shall host up to 8 expansion modules with various I/O combinations. These inputs and outputs shall include universal 12-bit inputs, binary triac outputs, and 8-bit switch-selectable analog outputs (0-10V or 0-20mA). Inputs shall support 3K and 10K thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.

8. Outputs shall have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.

9. The position of each HOA switch shall be available system wide as a BACnet object. The expandable central plant controller shall provide up to 176 discreet inputs/outputs per base unit.

B. BACnet Conformance:

1. AHU controllers shall, as a minimum, support PTP, MS/TP and Ethernet BACnet LAN types. It shall communicate directly through these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between supported LAN types. Controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.

2. Standard BACnet object types supported shall include, as a minimum, Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event Enrollment, Notification Class, Program, and Schedule object types. Necessary tools shall be supplied for working with proprietary information.

3. The Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Shall support interoperability on WANs and CANs, and function as a BBMD.

C. Schedules:

1. Each AHU controller shall support a minimum of 50 BACnet Schedule Objects.

D. Logging Capabilities:

1. Each controller shall support a minimum of 200 trend logs. Any object in the system (real or calculated) may be logged. Sample time intervals shall be adjustable at the operator's workstation.

2. Controller shall periodically upload trended data to system server for long-term archiving if desired.

3. Archived data stored in database format shall be available for use in third-party

spreadsheets or database programs.

E. Alarm Generation:

1. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

2. Alarm logs shall be provided for alarm viewing. Logs may be viewed on-site at the operator's terminal or off-site using remote communications.

3. The controller shall be able to handle up to 200 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

2.6 AUXILIARY CONTROL DEVICES

A. Temperature Sensors: Temperature sensors to be solid-state electronic, interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake, and in a location that is in the shade most of the day.

B. Wall Sensor: Standard wall sensor shall use solid-state sensor identical to intelligent room sensor and shall be packaged in aesthetically pleasing enclosure. The sensor shall provide override function, warmer/cooler lever for set point adjustment and port for plug-in of Field Service Tool for field adjustments. Override time shall be stored in controller and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller. Programmable variables shall be available to field service tool through wall sensor port.

C. Duct-mounted averaging type temperature sensor shall utilize a nickel resistance sensing element incorporated in a copper capillary of 24 feet. The sensor shall vary the output voltage with a change in temperature. Sensor shall connect to the remote controller by means of a three-wire unshielded cable.

D. Differential pressure sensor shall vary the output voltage with a change in differential pressure. The sensor shall connect to the remote controller by means of a three-wire unshielded cable. Use 0-.3" WC for building static. Sensor accuracy shall be plus or minus 2% of the span. Reference sensor to outside for duct static control.

E. Air velocity sensor shall be capable of linear indication of the velocity of air in a duct from 0 to 3000 FPM and shall vary its output voltage with a change in air velocity. The sensor shall connect to the controller by means of a four-wire unshielded cable. Velocity sensors for building pressure shall be 0-1000 FPM range. Repeatability shall be plus or minus 2% of the span.

F. Outdoor air sensor shall be of the thermistor (NTC) type with a high resistance change versus temperature change. Sensors shall be available for outdoor or duct mounting. The sensor shall connect to remote controller by means of a two-wire unshielded cable. An outdoor type sensor shall be available with integral wind sensor which changes its output voltage with a change in wind velocity. Combination sensor shall connect to controller by means of five-wire unshielded cable.

G. Differential Pressure Switches: Pressure differential switches shall have SPDT changeover contact, switching at an adjustable differential pressure setpoint.

H. Current Sensing Relays: Motor status indications, where shown on the plans, shall be provided via current sensing relays. The switch output contact shall be rated for 30 VDC, .15 amps.

I. Network Connection Tool:

1. Network connection tool shall allow technician to connect a laptop to any MS/TP network or at any MS/TP device and view and modify information throughout the entire BACnet network. The laptop connection to the tool shall be through Ethernet or PTP.

2. Provide quick connect to MS/TP LAN at each controller. Tool shall be able to adjust to MS/TP baud rates specified in the BACnet standard.

3. Provide 1 Network Connection Tools for this project.

2.7 OPERATOR WORKSTATION (EXISTING IN PLACE)

A. LOCAL AREA NETWORK PROTOCOL:

1. New ACM panels shall be connected to the plant network through an Ethernet jack.

2.8 INTERFACE TO REMOTE INTELLIGENT DEVICES: The system shall provide capability to communicate DDC temperature controls that are normally installed throughout the facility. This capability shall allow monitoring and control of these devices from the PC (operators workstation). The communications capability for this feature shall be accomplished within the ACM. These devices are to be furnished and installed by this contractor!

2.9 GLOBAL CONTROLLER HARDWARE:

A. Provide a fully configured PC with capabilities to match current technology with vendor software to manage Alerton DDC installations.

1. General: Provide a complete hardware system which has a proven track record of compatibility with the Control Vendors software. (Dell or Hewlett Packard,

with standard, generic components).

2. Pentium 4 based (or latest superseding chip set edition) personal computer (PC)
   a. Full 32-bit processor
   b. 3.0 mega-hertz minimum clock speed
   c. Minimum 512 megabytes of RAM
   d. 1.44-megabyte diskette
   e. 48 x CD read/write drive
   f. DVD read/write drive
   g. 80 gigabyte or greater IDE hard disk drive.
   h. AGP Video Card 128 meg ram
   i. Network card (Ethernet 10 Mbps)
   j. Complete with mouse, keyboard, modem, and thin/flat SVGA color monitor.
   k. Optical mouse
   l. Provide operator keyboard with full upper / lower case ASCII keyboard, numeric keypad, cursor control keypad, and minimum of 12 programmable function keys.
   m. 56K Baud, auto dial, auto-answer, FAX modem
   n. 19-inch flat panel LCD color monitor with minimum SVGA resolution. Like ViewSonic VX series.

2. Complete with Windows Office operating system software, database manager 10

3. Remote Communications Anti-Virus, control software and applications software needed to comprise a fully functional workstation, all duly licensed in perpetuity, without recurring charges for renewal.

B. Provide all required programming for the complete and functional operation of the building control system. Including providing complete graphics and programming of the headend.

PART III - EXECUTION

3.1 COMPLETE SYSTEM:

A. Integrate all new controls into the existing Alerton System. Provide all controls and related functions, with all power and communications wiring, with sensors, room thermostats, actuators, valves, dampers, etc.

B. Participate in the checkout and commissioning and shake out of all of the mechanical systems. Provide complete and detailed checkout and testing of all controls and control sequences. Provide thermal rise trend recording and logs during system testing and shake out.

C. Contractor shall coordinate with owner’s personnel to get Ethernet jacks installed. For communication from front-end server to the jack panels in the field.

3.2 CONTROL SEQUENCES:

A. The sequences of control for the DDC system shall be equivalent to those specified for the base bid system with the added benefits of programmable algorithmic control.

B. Fully describe the sequences in the submittals.

C. Fully document all work by shop drawing and product bulletin submittal, work from reviewed drawings, maintain record documents during installation, provide a complete "As-Built" document set in PDF at completion.

3.3 SYSTEM ACCEPTANCE:

A. GENERAL: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request. When the field test procedures have been demonstrated to the Owner's representative, the system will be accepted. The warranty period will start at this time.

B. FIELD EQUIPMENT TEST PROCEDURES: DDC controls panels shall be demonstrated via a functional end-to-end test. Such that:

1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operations verified.

2. All analog input channels shall be verified for proper operation.

3. All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displaying value.

4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.

5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.

6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.

C. WORKSTATION TEST PROCEDURES: The system workstation test procedures shall be as follows:

1. Communication with each DDC control panel shall be demonstrated.

2. Operator commands will be explained and demonstrated.

3. Control sequences shall be demonstrated for proper operation.

4. All available system reports and logs shall be demonstrated at the system workstation.

5. Correct system start-up and shutdown procedures shall be demonstrated.

6. All controllers shall be demonstrated to operate in a standalone mode.

D. AS-BUILT DOCUMENTATION: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. After receiving final approval, supply "6" complete 11x17 as-built drawing sets, together with PDF File to the Owner.

E. OPERATION AND MAINTENANCE MANUALS: Submit two copies of operation and maintenance manuals. Include the following:

1. Manufacturer's catalog data and specifications on sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.

2. An operator's manual which will include detailed instructions for all operations of the system.

3. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.

4. A language manual which will include a detailed description of the language used and all routines used by the system.

5. Flow charts of the control software programs utilized in the DDC system.

6. Flow charts of the custom software programs utilized in the DDC system as approved.

7. Complete program listing file and parameter listing file for all programs.

8. A copy of the warranty.

9. Operating and maintenance cautions and instructions.

10. Recommended spare parts list.

END OF SECTION 230923

SECTION 230933 - ELECTRIC CONTROL SYSTEMS

PART I - GENERAL

1.1 RELATED DOCUMENTS: See Section 230900.

1.2 DESCRIPTION OF WORK:

A. Electric control functions and systems indicated on the drawings and specified herein.

B. Complete interrelationships with automation systems and mechanical equipment.

1.3 QUALITY ASSURANCE: See Section 230900.

1.4 SUBMITTALS: See Section 230900.

1.5 DELIVERY, STORAGE AND HANDLING: See Section 230900.

1.6 INSTRUCTION OF OWNER'S PERSONNEL: See Section 230900.

1.7 WARRANTIES: See Section 230900.

1.8 CLEANING AND LUBRICATION: See Section 230900.

1.9 TESTING AND ADJUSTING OF SYSTEM: See Section 230900.

PART II - MATERIALS AND METHODS

2.1 ELECTRICAL POWER SUPPLY:

A. Obtain power from Division 26 distribution panel. Furnish appropriate circuit breakers and extend conduit and wiring assigned to this division.

B. Furnish and install UL listed voltage reducing transformers required for this work. Size transformers to see no more than 70 percent of rated capacity at full load. Use industrial quality "machine tool" grade transformers.

C. Make all electrical installations in conformance with the National Electrical Code (current edition) and in accordance with Division 26.

D. Use the same product lines for similar devices as used by electrician to result in a coherent project.

E. Control Wiring:

1. All control wiring shall be installed in conduit per National Electric Code. The installation shall be square with the walls of the buildings.

2. Number and code all wiring.

F. Use no wire smaller than 16 gauge, no conduit smaller than 1/2".

2.3 FREEZESTATS:

Manual reset, non-averaging, extended capillary tubes. Honeywell L-480G, Johnson A11A-I/A70HA-1, Staefa 134-1511. Penetrate plenum wall with grommet protection, support capillary on 1/4" copper tubing. Use DPDT action as needed or auxiliary relays with powered circuits.

2.5 AUXILIARY RELAYS:

Light Duty – Functional Devices RIB relay series

2.6 PRESSURE SWITCH FOR DIRTY FILTER INDICATION:

.05 - 12" wg adjustable Dwyer 1630, Staefa 141-0518.

Johnson P-32.

2.7 TIME DELAY RELAYS:

Agastat Series 7000 with appropriate action or approved equal.

2.8 HAND/AUTO SWITCHES, manual analog output devices (potentiometers), hand graduals, etc., as needed.

2.9 ELECTRIC DAMPER ACTUATORS:

A. General Actuators: Push-pull, or rotary for modulating, 3 point floating, or 2-position control to suit duty. Size motor to damper for non-overloading characteristics. Fit with adjustable position and switches to limit stroke. Select voltage to work with local and overall system from 120 VAC, 24 VAC, 0-10 VDC or 4-20 ma. Set up with spring return to normal position or loss of power.

B. Manufacturer: Seimens, Belimo.

2.10 ELECTRIC DAMPER ACTUATORS FOR OUTSIDE, RETURN, AND RELIEF DAMPERS AND OTHER ACTUATORS REQUIRING SPRING RETURN:

A. Damper actuators shall have an internal mechanical spring return for power failure and safety applications. Spring return actuators shall be capable of CW or CCW mounting. The actuators shall be of sufficient capacity to provide a minimum of 5 in-lb/sq.ft. for opposed blade dampers and 7 in-lb/sq.ft. for parallel blade dampers. All actuators shall be brushless DC motors. Mounting shall provide for servicing and proper alignment with the damper shaft to minimize drag and slippage on the shaft. Actuators shall have a 5 year warranty.

B. Manufacturer: Siemens, Belimo.

END OF SECTION 230933

SECTION 232000 - GENERAL PIPES AND FITTINGS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-23 General Pipes and Fittings section, and is part of each Division-23 section making reference to pipes and pipe fittings specified herein.

C. Division-23 General Mechanical Requirements apply to work of this section.

1.2 SUMMARY:

A. This section is generic in that it describes material and installation required by several other sections of this specification.

B. Types of pipes and pipe fittings specified in this section include the following:

1. Steel Piping
2. Copper Piping
3. Cast-Iron Pressure Piping
4. Cast-Iron Soil Piping
5. Grooved Joint Piping
6. Miscellaneous Piping Materials/Products.

C. Pipes and pipe fittings furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications:

1. Firm with at least three years history of successful experience on projects of similar nature.

2. Licensed as a firm in the contractor state of origin and in the State of Utah.

3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the contractor.

4. All workmen employed on the project to carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

C. Welding Certification:

1. Each welder shall have passed a qualification test within the past six months

prior to working on the project.

2. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.

3. The test report shall certify that the welder is qualified to weld the material to be used at the job site in the positions required (flat, verticle, overhead etc).

4. Submit three copies of each welder's qualification test report to the Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

B. Welding Certifications: Submit reports as required for piping work.

C. Brazing Certifications: Submit reports as required for piping work.

D. Maintenance Data: Submit maintenance data and parts lists for each type of mechanical fitting. Include this data, product data, and certifications in maintenance manual; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes And Standards:

1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.

2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

3. NSF Labels: Where plastic piping is indicated to transport potable water, provide pipes and pipe fittings bearing approval label by National Sanitation Foundation (NSF).

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store pipe in a manner to prevent sagging and bending.

B. Store pipe in a manner to prevent dirt and debris from entering piping. When possible store steel and copper pipes and tubing inside and protected from weather. Whether stored inside or outside elevate above grade and enclose with durable waterproof wrapping. Raise slightly one end of sealed piping to prevent accumulations of condensate and pitting where condensate accumulates.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART II - PRODUCTS

2.1 GENERAL:

A. Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards. Use United States (domestic) manufactured pipe only. Do not use foreign made pipe. Any request for deviation from this requirement is to be made prior to bid time through a detailed request for substitution/prior approval process. Requests made after bid time will not be accepted.

B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable. Use United States (domestic) manufactured fittings only. Do not use foreign manufactured fittings. Any request for deviation from this requirement is to be made prior to bid time through a detailed request for substitution/prior approval process. Requests made after bid time will not be accepted.

2.2 STEEL PIPES AND PIPE FITTINGS:

A. Black Steel Pipe: Seamless or ERW, ASTM A 53.

B. Galvanized Steel Pipe: ASTM A 53.

C. Galvanized Seamless Steel Pipe: ASTM A 53.

D. Electric-Resistance-Welded Steel Pipe: ASTM A 135.

E. Electric-Fusion-Welded Steel Pipe: ASTM A 671, A 672, or A 691.

F. Cast-Iron Flanged Fittings: ANSI B16.1, including bolting.

G. Cast-Iron Threaded Fittings: ANSI B16.4.

H. Malleable-Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated.

I. Unions: ANSI B16.39; 300 lb. ground joint malleable iron, hexagonal, selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.

J. Dielectric Unions: 175 psig WSP at 250^{o}F. Equal to Walter Vallet Company V-line insulating coupling.

K. Threaded Pipe Plugs: ANSI B16.14.

L. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.

1. Material Group: Group 1.1.

2. End Connections: Buttwelding.

3. Facings: Raised-face.

4. Steel Pipe Flanges For Waterworks Service: AWWA C207.

M. Forged-Steel and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe.

N. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.

O. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2", and where pipe size is less than 1-1/2", and do not thread nipples full length (no close-nipples).

2.3 COPPER TUBE AND FITTINGS:

A. Copper Tube: ASTM B 88; Type K, L (wall thickness) as indicated for each service; hard-drawn temper, except as otherwise indicated. Do not use Type M piping.

B. DWV Copper Tube: ASTM B 306.

C. ACR Copper Tube: ASTM B 280.

D. Cast-Copper Solder-Joint Fittings: ANSI B16.18.

E. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.

F. Cast-Copper Solder-Joint Drainage Fittings: ANSI B16.23.

G. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.

H. Cast-Copper Flared Tube Fittings: ANSI B16.26.

I. Bronze Pipe Flanges/Fittings: ANSI B16.24.

J. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

2.4 CAST-IRON SOIL PIPES AND PIPE FITTINGS:

A. Hubless Cast-Iron Soil Pipe: FS WW-P-401.

B. Cast-Iron Hub-and-Spigot Soil Pipe: ASTM A 74.

C. Hubless Cast-Iron Soil Pipe Fittings: Neoprene gasket complying with ASTM C 564 and stainless steel clamp holding band.

D. Cast-Iron Hub-and-Spigot Soil Pipe Fittings: Match soil pipe units; complying with same standards (ASTM A 74).

E. Compression Gaskets: ASTM C 564.

2.5 GROOVED PIPING PRODUCTS: (Only where acceptable.)

A. General: At Installer's option, mechanical grooved pipe couplings and fittings may be used for piping systems having operating conditions not exceeding 230°F (110°C), excluding steam piping, condensing water return to pump, and any other service not recommended by manufacturer, in lieu of welded, flanged, or threaded methods, and may also be used as unions, seismic joints, flexible connections, expansion joints, expansion compensators, or vibration reducers.

B. Coupling Housings Description: Grooved mechanical type, which engages grooved or shouldered pipe ends, encasing an elastomeric gasket which bridges pipe ends to create seal. Cast in two or more parts, secure together during assembly with nuts and bolts. Permit degree of contraction and expansion as specified in manufacturer's latest published literature. (Victaulic style 77) For rigid joints (Victaulic "Zero Flex" style 07).

1. Coupling Housings: Malleable iron conforming to ASTM A 47.

2. Coupling Housings: Ductile iron conforming to ASTM A 536.

3. Standard: Enamel coated, options hot dip galvanized.

C. Gaskets: Mechanical grooved coupling design, pressure responsive so that internal pressure serves to increase seal's tightness, constructed of elastomers having properties as designated by ASTM D 2000.

1. Water Services: EPDM Grade E, with green color code identification.

2. Other Services: As recommended by Manufacturer.

D. Bolts and Nuts: Heat-treated carbon steel, ASTM A 183, minimum tensile 110,000 psi.

1. Exposed Locations: Tamper resistant nuts.

E. Branch Stub-Ins: Upper housing with full locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts.

F. Fittings: Grooved or shouldered end design to accept grooved mechanical couplings.

1. Malleable Iron: ASTM A 47.

2. Ductile Iron: ASTM A 536.

3. Fabricated Steel: ASTM A 53, Type F for 3/4" to 1-1/2"; Type E or S, Grade B for 2" to 20".

4. Steel: ASTM A 234.

G. Flanges: Conform to Class 125 cast iron and Class 150 steel bolt hole alignment.
1. Malleable Iron: ASTM A 47.

2. Ductile Iron: ASTM A 536.

H. Specialties:

1. Dielectric couplings. Victaulic Style 47.

I. Grooves: Conform to the following:

1. Standard Steel: Roll grooved.
2. Ductile Iron: Radius cut grooved, AWWA C606.

J. Manufacturer: Subject to compliance with requirements, provide grooved piping products of one of the following:

1. Victaulic Co. of America.
2. Tyco
3. Victaulic (North America)

K. Coordination with Section 230700: Insulation of coupled piping is more difficult and expensive than is that of welded piping related to couplings, coupling ears, and more involved support. Where coupled piping is used, include all extra cost in the proposal. Install such at no additional cost to the owner.

2.6 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.

1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements. Use no lead bearing solders in domestic water applications.

1. Tin-Antimony Solder: ASTM B 32, Grade 95TA.

2. Silver-Lead Solder: ASTM B 32, Grade 96TS.

C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.

1. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

1. Manufacturer: Subject to compliance with requirements, provide piping connectors of the following:

a. Fernco, Inc.

F. Strainers:

1. Y pattern, self cleaning, line size. Armstrong, Bailey, Crane, Fisher, Metraflex, Mueller, Sarco, Strong, or Yarway.

a. Iron Body, Screwed Ends 2" and Smaller: 250 psig at 425°F, screen mesh to suit service.

b. Flanged Iron Body 21/2" and Larger: 125 psig steam pressure rating, screen mesh to suit service.

PART III - EXECUTION

3.1 INSTALLATION:

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently- leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible union, flanges, etc., for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Do not cold spring. Store filler weld materials in accordance with codes.

1. Comply with ANSI B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated. Provide high point vents, low point drains with valves and extension to drain for all piping.

C. All piping in mechanical rooms, fan rooms, etc., shall be exposed. Do not conceal or imbed piping in walls, floors or other structures.

D. Make changes in direction or size with manufactured fittings. Anchor and support piping for free expansion and movement without damage to piping, equipment or to building.

E. Arrange piping to maintain head room and keep passageways clear.

F. Provide unions at connections to equipment and elsewhere as required to facilitate maintenance.

G. Run full pipe size through shutoff valves, gas cocks, balancing valves, etc. Change pipe size within three pipe size diameters of final connection to equipment, coils, etc.

H. Erect all piping to insure proper draining. Domestic water, chilled water, and heating water shall slope down a minimum of 1" per 40 feet towards the drains. Pitch standpipes down to fire department connections a minimum of 1" per 40 feet. Slope soil, waste, vent, and roof drain lines in accordance with requirements of Uniform Plumbing Code.

I. On horizontal straight runs of pipe, use eccentric reducers with straight side on top for water piping.

J. Electrical Equipment Spaces: Do not run piping in or through transformer vaults and other electrical or electronic equipment spaces and enclosures or above electrical gear unless authorized and directed. Install drip pan under piping that must be run through electrical spaces.

3.2 PIPING SYSTEM JOINTS:

A. General: Provide joints of type indicated in each piping system.

B. Threaded: Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

C. Brazed: Braze copper tube-and-fitting joints where indicated, in accordance with ASME B31.

D. Soldered: Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E. Welded:

1. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.

2. Weld pipe joints in accordance with recognized industry practice and as follows:

a. Weld pipe joints only when ambient temperature is above $0^{o}F$ ($-18^{o}C$) where possible, with minimum pipe preheat to $50^{o}F$.

b. Bevel pipe ends at a 37.5^{o} angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.

c. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".

d. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.

e. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

f. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.

g. At Installer's option, install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.

F. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

G. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.

H. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.

3.3 CLEANING, FLUSHING, INSPECTING:

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Flushing shall consist of not less than six (6) short intermittent flushes of five (5) to ten (10) minutes duration. Sample and test each flush for cleanliness. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31.

B. Disinfect water mains and water service piping in accordance with AWWA C601.

C. Clean, flush as above and treat heating and cooling systems in accordance with Sections chemical treatment. Certify by signature of Contractor and Owner's Representative.

3.4 PIPING TESTS:

A. General: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

1. Required test period is 2 hours.

2. Test long runs of Schedule 40 pipe at 150 psi, except where fittings are lower Class or pressure rating.

3. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.

4. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

B. Notifications: At least 10 days prior to commencement of required testing, notice shall be submitted for review. Tests shall be made prior to painting insulating or covering of any joints and shall be in accordance with ANSI Code for Pressure Piping.

C. Inspections: Contractor to visually inspect piping while under hydrostatic pressure. Copies of inspection shall be submitted for review. At option of contract, welds not hydrostatically tested may be x-ray tested.

D. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

E. Drain test water from piping systems after testing and repair work has been completed.

F. Test pressure piping in accordance with ANSI B31.

G. Test waste, drain and vent systems in accordance with local plumbing code and these specifications. Repair failed sections by disassembly and reinstallation.

H. If test procedures in other sections differ from the above, comply with more stringent requirements.

END OF SECTION 232000

SECTION 232300 - REFRIGERATION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL MECHANICAL REQUIREMENTS:

A. All pertinent sections of Section 230000 - General Mechanical Requirements are a part of the work described in this section.

B. All pertinent sections of Division 22 - General Requirements for Plumbing and Piping are a part of the work described in this section.

1.02 RELATED SECTIONS:

A. Section 03300 – Cast-in-Place Concrete: Equipment bases.

B. Section 230548 – Mechanical, Sound, Vibration and Seismic Control.

C. Section 230719 – Refrigerant Piping Insulation.

D. Section 230700 – Mechanical Insulation.

E. Section 230900 – Mechanical Control Systems

F. Section 26____ - Equipment Wiring Systems.

1.03 SUMMARY:

A. This section includes:

1. Refrigeration piping systems for air conditioning equipment.
2. Condensing unit package
3. Heat pump packages
4. Charge of refrigerant and oil.
5. Controls and control connections.
6. Refrigerant piping connections.
7. Motor starters.
8. Electrical power connections.

1.04 STANDARDS:

A. International Building Code/International Mechanical Code

B. Local Codes and Ordinances

C. EPA Requirements.

D. ANSI/AHRI 340/360- Performance rating of commercial and industrial unitary air-conditioning and heat pump equipment (heat pumps and condensing units greater than 65,000 BTUH and below 250,000 BTUH.

E. UL1995 - Unitary Air Conditioning Standard for safety requirements.

F. AHRI 270 - Sound Rating of Outdoor Unitary Equipment, (units less than 135,000 Btuh).

G. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration.

H. ANSI/ASHRAE 90A – Energy Conservation in new Building Design.

I. AHRI 370 – Sound Rating of Large Refrigeration and Air-conditioning Equipment.

J. AHRI 365 – Unitary Air-Conditioning Equipment.

1.05 SHOP DRAWINGS/SUBMITTALS:

A. Submit a list of all materials to be used indicating brand or source, type and service.

B. Submit shop drawings for all equipment, valves and specialties, including shop drawing showing proposed pipe routing, sizing, valving, etc.

C. Submit unit performance data including capacity, nominal and operating performance.

D. Submit Mechanical Specifications for unit and accessories describing construction, components, and options.

E. Submit shop drawings indicating overall dimensions as well as installation, operation, and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

F. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety, and start-up instructions.

1.06 CONTRACTOR QUALIFICATIONS:

A. The contractor for this work shall be licensed as a firm in the Contractor state of origin and in the state where the work is performed.

B. The Contractor shall have a publicly registered bonding capacity of a sufficient amount to cover this work and all other work in progress by the Contractor.

C. All workers employed in the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.07 SCOPE OF THE WORK:

A. Furnish and install all field fabricated refrigeration systems and related work to affect a complete installation.

1. Provide and install complete refrigeration piping systems and equipment for split air conditioning systems as indicated in the Contract Documents and as specified in this section. Make systems fully operational.

2. Piping, valves, specialties.

3. Condensing units.

4. Heat pumps.

5. Other work indicated on the drawings.

1.08 INSTRUCTION OF OWNER'S PERSONNEL:

A. Purpose is to provide a transition of the systems from the Contractor to the Owner, leaving the Owner's personnel familiar with and well qualified to operate and maintain the systems.

B. Instruction to cover purpose and function of each system and its components, to show proper operating technique, to show proper maintenance technique.

1.09 DELIVERY, STORAGE, AND HANDLING:

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage. Protect coils.

1.10 WARRANTIES: See Section 230000.

A. Provide a one-year parts warranty for each unit.

B. Provide 5-year limited compressor warranty for each unit.

1.11 OPERATION AND MAINTENANCE DATA:

A. Submit operation and maintenance data for each unit.

B. Include manufacturer's descriptive literature, start-up instructions, installation instructions, and maintenance procedures for unit.

1.12 MAINTENANCE:

A. All work on units shall be accomplished by OEM factory trained and authorized service technicians.

1.13 ACOUSTICS:

A. Manufacturer of condensing unit and heat pump units shall provide outdoor sound power level at gross cooling capacity, and at significant part-load stages (for units equipped to be operated in stages). Outdoor sound shall consist of radiates sound power for each octave band from 63Hz to 8kHz. Data shall be obtained in accordance with ANSI/AHRI Standard 370.

1.14 REGULATORY REQUIREMNTS:

A. Units shall conform to UL 1995, CAN/CSA C22.2 NO. 236-95 for construction of condensing units and shall have cULus label affixed to unit.

1. In the event the unit is not UL/CSA approved, the manufacturer shall, at his expense, provide for a field inspection by a UL representative to verify conformance to cULus standards, if necessary, contractor shall perform required modifications to the unit to comply with UL, as directed by the UL representative, at no additional expense to the Owner.

PART 2 - PRODUCTS

2.01 EQUIPMENT: All major items of refrigeration equipment shall be as specified in the equipment schedules on the drawings and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory operating system.

2.02 PIPING MATERIALS: Piping materials shall be as follows unless otherwise indicated on the applicable contract drawing:

A. Pipe: "ACR" Type L, hard drawing, degreased, sealed at mill copper tubing, ASTM B88-62, cleaned and sealed at the mill. Pre-charged refrigerant lines shall not be used.

B. Fittings: Long radius, wrought copper type equal to Mueller Streamline, ASA B16.22.1963.

2.03 VALVES, SPECIALTIES, ETC:

A. Filter-Dryer: On lines smaller than 3/4" O.D. filter-dryer shall be a sealed type using male flare fittings. Size shall be full line size. Filter-dryer shall be Sporlan, Mueller or Alco.

B. Sight Glass: Shall be a combination moisture and liquid indicator with protection cap. Sight glass shall be Alco, Mueller, Sporlan or Henry. Size shall be full line size.

C. Flexible Connection: Corrugated bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for system working pressure.

D. Solenoid Valve:

1. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly with flared, solder, or threaded ends; for system working pressure. Stem shall permit manual operation in case of coil failure.

2. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box 24 volt, confirm and coordinate with DDC controls.

2.04 REFRIGERANT AND LUBRICATING OIL: The Contractor furnish and install all of the refrigerant required to develop the system to its full rating, and in addition to the initial charge, he shall be required to provide, without cost to the Owner, all required refrigerant for the proper operation of the refrigeration apparatus during the first year's operation. The contractor shall be required to provide the initial charge of lubricating oil for all refrigeration apparatus and related equipment. Loss of refrigerant and oil during the first year of operation shall be made good at the contractor's expense.

2.05 CONDENSING UNIT:

A. GENERAL UNIT DESCRIPTION:

1. Provide self-contained, packaged, factory-assembled and pre-wired unit suitable for outdoor use consisting of cabinet, compressors, condensing coil, and fans, subcooling circuit(s), and controls.

B. CASING:

1. Unit shall be constructed of 14-gauge welded galvanized steel frame with 14 and 16-gauge galvanized steel panels and access doors. Unit shall have factory mounted, louvered, full-length steel grilles to protect the condenser coils and piping. Unit surface shall be phosphatized and finished with an air-dry paint. This air-dry paint finish shall be durable enough to withstand a minimum of 672-consecutive-hour salt spray application in accordance with standard ASTM B117.

C. CONDENSER SECTION:

1. Condenser coils shall have all Aluminum Microchannel coils. All coils shall be leak tested at the factory to ensure pressure integrity. The condenser coil shall be pressure tested to 650 psig.

2. Provide factory mounted, louvered, full- length steel grilles to protect the condenser coils and piping.

D. REFRIGERANT CIRCUIT(S):

1. Provide single circuit.

2. Installer shall provide and install Bleed Thermal Expansion valve. 30% or 15% Bleed thermal Expansion valve shall be used. Quantity and size shall be based on the application and determined by the installer. Note: Liquid line solenoids are required for all applications. Trim solenoids cannot be used.

3. Provide Suction Service Valve. Unit shall include a refrigerant shut off valve to isolate the compressor for servicing.

4. Provide Pressure gauges. Gauges shall be provided for monitoring suction and discharge pressure. One set shall be provided for each circuit.

E. FANS AND MOTORS:

1. Condenser Fans shall have Vertical discharge, direct drive fans with aluminum blades and zinc plated steel hubs guard on discharge. Fans shall be statically and dynamically balanced.

2. Condenser fan motors shall be three-phase motors with permanently lubricated ball bearings, built in current and thermal overload protection and weather-tight slingers over motor bearings.

F. COMPRESSORS:

1. Scroll compressors shall provide low vibration. Compressors shall have a completely enclosed compression chamber with no leakage paths. The compressor(s) shall be suction gas cooled, direct drive, with 3600 RPM hermetic motors. The scroll compressor shall include a centrifugal oil pump, oil level sight glass, and an oil charging valve.

2. Motor shall be designed for across-the-line starting and suitable for a voltage utilization range of +/- 10 percent from nameplate voltage.

G. SYSTEM CONTROLS:

1. No System Control: Provide compressors wired to a terminal strip inside the control panel. Include guaranteed fixed-on and -off timers for compressor protection. Temperature controls not included in unit.

2. Unit Control: Factory-provided 115-volt control circuit includes fusing and control power transformer. The unit is wired with magnetic contactors for compressor and condenser motors. Three-leg circuit breakers are used for overload and short circuit protections. The unit also has high/low pressure cutouts. Charge isolation, reset relay and anti-recycle compressor timer is provided. Across- the- line start is standard.

H. MISCELLANEOUS FEATURES:

1. Provide a Low ambient option that shall allow unit operation down to 0°F using fan cycling and head pressure control dampers. The control shall consist of a heavy gauge damper assembly that is modulated by an actuator. The actuator shall be controlled by a low ambient control module. All components are factory mounted.

2. Provide a non-fused disconnect switch. Disconnect shall be mounted in the control box and provides for interruption of power for servicing the unit. The lugs shall be suitable for copper wires only. No overcurrent or short circuit protection is provided for units by this switch.

3. Provide powered convenience outlet. 115v/15amp ground fault interrupter convenience outlet shall be factory installed with a single point power entry from a factory mounted transformer. It shall meet NEC 210-63 requirements. This outlet shall include a separate disconnect switch so that the outlet is powered when the unit disconnect switch is off.

4. Provide Hot Gas Bypass Valve. The valve shall modulate hot gas to the inlet of the evaporator when suction pressure falls below the valve adjustable set point. Electronic versions shall be available with control through temperature or pressure.

2.06 HEAT PUMP UNITS (HP-1 thru 3):

A. General Unit Description:

1. The contractor shall furnish and install an air-cooled heat pump unit as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2. Approved Manufacturers:

a. Mitsubishi

b. Substitutions: No substitutions allowed for these units as they must be compatible with the existing systems that are to remain in place.

B. General Unit Description:

1. Provide self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral subcooling circuit(s), filter drier(s), and controls. Provide expansion valve(s) and check valves for split system heat pump unit(s).

2. Performance Ratings: Energy Efficiency Rating (EER) [and Coefficient of Performance (COP)] not less than prescribed by ANSE/ASHRAE 90.1

C. Casing:

1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.

2. Panels on the outdoor unit shall be scratch free at system startup.

D. Condenser Coils:

1. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.

2. Outdoor Coil shall be elevated at least 12” from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer’s in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12” of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.

3. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

4. The coil shall be protected with an integral metal guard.

5. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

6. Unit shall have prewired plugs for optional panel heaters in order to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.

7. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.

E. Fans and Motors:

1. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG external static pressure, but capable of normal operation with a maximum of 0.32 in. WG external static pressure via dipswitch.

2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

3. fans shall be provided with a raised guard to prevent contact with moving parts.

F. Compressors:

1. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.

2. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.

3. Compressor (or compressor circuit) must utilize hot gas injection circuit or two-stage compression to allow compression ratio (thus heating output) to increase during extreme cold ambient temperatures.

4. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.

5. All compressors shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.

6. The compressor shall be equipped with an internal thermal overload.

7. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

8. Manufacturers that utilize a compressor sump oil sensor to equalize

compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.

G. Panel Heater:

1. Each outdoor unit module shall be equipped with a panel heater to protect coil against ice build-up during prolonged winter operation. Panel heater shall activate only if compressor is operating in heating mode at an outdoor ambient temperature of 39F or below.

H. Controls:

1. The Outdoor unit shall include Variable Evaporator Temperature or comparable method of varying system evaporator (refrigerant) temperature in order to reduce compression ratio and power consumption during light load or mild ambient temperatures. Multiple evaporator refrigerant temperature settings shall be required in order to optimize efficiency within required system-specific performance and installation constraints. System shall reduce compression ratio only when/if all indoor units are within 1.8F of setpoint; reducing compression ratio based solely on ambient temperature risks discomfort and is not allowed. Variable Evaporator Temperature or comparable method shall incorporate override or disable capability based on external signal to allow for space humidity control or load demand.

2. The unit shall be an integral part of the system & control network described in Part 5 (Controls) and react to heating/cooling demand as communicated from connected indoor units over the control circuit. Required field-installed system controllers, control voltage transformers and/or signal boosters shall be provided by the manufacturer.

3. The outdoor unit shall have the capability of 4 levels of demand control for each refrigerant system based on external input.

I. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz per equipment schedule.

2. The outdoor unit shall be controlled by integral microprocessors.

3. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.07 AIR TO WATER HEAT PUMP UNIT (HP-4): Two required.

A. General Unit Description:

1. The contractor shall furnish and install an air-cooled heat pump unit as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2. Approved Manufacturers:

a. Apollo
b. Arctic
c. Substitutions: [prior approval required] as indicated under the general and/or supplemental conditions of these specifications.

B. General Unit Description:

1. Provide self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral subcooling circuit(s), filter drier(s), and controls.

2. Performance Ratings: Energy Efficiency Rating (EER) [and Coefficient of Performance (COP)] not less than prescribed by ANSE/ASHRAE 90.1

C. Casing:

1. House components in heavy gauge galvanized steel frame and panels with weather resistant, baked enamel finish. Units surface shall be tested 672 hours in salt spray test.

2. Mount controls in weatherproof panel provided with removable panels and/or access doors with quick opening fasteners.

D. Condenser Coils:

1. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide subcooling circuit(s). Factory leak test in helium chamber, and vacuum dehydrate. Seal with holding charge of nitrogen.

E. Fans and Motors:

1. Brushless DC fan motor with PFC control method.

F. Compressors:

1. Compressor(s): Enhanced vapor injection (EVI) DC inverter compressor.

G. Building Management System:

1. Unit shall be provided with BACnet communication ability, able to communicate with BACnet IP or BACnet MS/TP.

2. BACnet option is to be factory installed.

2.08 HEAT PUMP UNIT (HP-5):

A. Summary:

1. The contractor shall furnish and install an air-cooled heat pump unit as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2. Approved Manufacturers:

a. Trane:

b. Substitutions: [prior approval required] as indicated under the general and/or supplemental conditions of these specifications.

B. General Unit Description:

1. Provide self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral subcooling circuit(s), filter drier(s), and controls. Provide expansion valve(s) and check valves for split system heat pump unit(s).

2. Performance Ratings: Energy Efficiency Rating (EER) [and Coefficient of Performance (COP)] not less than prescribed by ANSE/ASHRAE 90.1

C. Casing:

1. House components in heavy gauge galvanized steel frame and panels with weather resistant, baked enamel finish. Units surface shall be tested 672 hours in salt spray test.

2. Casing shall have removable single side maintenance access panels, lifting handles, and provision for forklift and/or crane lifting.

3. Mount controls in weatherproof panel provided with removable panels and/or access doors with quick opening fasteners.

D. Condenser Coils:

1. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide subcooling circuit(s). Factory leak test in helium chamber, and vacuum dehydrate. Seal with holding charge of nitrogen.

E. Fans and Motors:

1. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Fans shall be statically and dynamically balanced.

2. Weatherproof motors suitable for outdoor use, with permanently lubricated open air over (OAO) motors shall be provided and shall have built in thermal overload protection. Motors shall be rated IPX4 and shall have full contact ball bearings.

F. Compressors:

1. Compressor(s): Provide direct-drive scroll compressor(s) with centrifugal oil pump providing positive lubrication to moving parts. Motor shall be suction gas-cooled with internal temperature and current sensitive motor overloads. External high and low pressure cutout devices shall be provided.

G. Controls:

1. The control shall be a centralized microprocessor with indoor and outdoor temperature sensors that drive algorithms, making decisions for all heating, cooling, and ventilation.

a. The control shall have an integrated anti-short-cycle timer and integrated time delay between compressors.

b. Connectors shall be colored and keyed with colored wires.

H. Building Management System:

1. Unit shall be provided with BACnet communication ability, able to communicate with BACnet IP or BACnet MS/TP.

a. BACnet option is to be factory installed.

PART III - EXECUTION:

3.01 INSTALLATION:

A. General: Use best practices of the trade in all installation. Installation shall conform with the American Standard Code for Pressure Piping, ASA B31.5-1962, Refrigeration Piping. Installed piping shall not interfere with the operation and accessibility of doors or windows; shall not encroach on aisles, passageways, and equipment; and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping installation is not permitted. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping shall be installed in a straight manner, free from traps, and shall be provided with capped or plugged ends, as it is erected, to prevent dirt from entering the system. The piping system shall be provided with isolating hangers as required to prevent vibration of the compressor operation being carried to the building structure. The piping system shall be provided with gauges as required for the operation of the system, and the suction connection from each coil shall be provided with a test thermometer wall in the pipe for adjustment of the thermostatic expansion valves.

B. Slope of Refrigerant Lines: Slope suction lines down toward compressor 1" per 10 feet. Locate oil traps every 10 feet at all vertical rises against flow in suction lines. Suction line traps shall be standard one-piece traps.

C. Cleanliness: All refrigerant lines and fittings shall be clean to avoid system operating difficulties and contamination. Use a good cleaning agent such as trichloroethylene.

D. Joints:

1. Brazed joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool, wire brush, or fine emery cloth before sweating.

   An inert gas (such as oil pumped dry nitrogen) shall be continuously passed through the copper piping when brazing joints to prevent formation of copper oxide. Care shall be taken to prevent annealing of fittings and tubing when making connections. Joints shall be made with silver bearing brazing material.

3.02 TESTING OF REFRIGERATION PIPING SYSTEM: After the installation of the refrigeration piping system has been completed and before insulation is applied, all

pipes shall be tested and proven tight for a period of 24 hours at a pressure of 300 pounds per square inch using oil pumped dry nitrogen.

3.03 EVACUATION AND CHARGING: After completion of the piping pressure test, the refrigeration systems shall be evacuated and dehydrated using a vacuum pump capable of producing at least 1 mm Hg absolute. The following procedure shall be followed unless otherwise noted:

A. Connect an accurate high vacuum gauge, such as Stokes or Zimmeril gauge to the system.

B. Connect the vacuum pump to both the high and low side of the system. Leave the compressor suction and discharge service valves closed. Start the vacuum pump.

C. Keep ambient air temperatures above 60^{o} during the evacuation process.

D. Operate the vacuum pump until the system is evacuated to 2.5 mg Hg absolute.

E. Break the system vacuum with oil pumped dry nitrogen. Open the compressor suction and discharge service valves and re-evacuate the system to 2.5 mm Hg absolute.

F. After the system has been double evacuated to 2.5 mm Hg absolute, close the vacuum pump suction valve and stop the pump. Allow the system to stand under a vacuum a minimum of 12 hours. If no noticeable rise in pressure has taken place after 12 hours, the system may be charged. This test shall be made in the presence of the Owner's representative.

3.04 INSTALLATION OF CONDENSING UNITS AND HEAT PUMPS:

A. General: Install condensing units and heat pumps in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored on concrete pads in locations indicated, and maintain manufacturers recommended clearances.

B. Electrical Wiring: Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer’s electrical connection diagram submittal to electrical contractor.

C. Piping Connections: Install and connect devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturers piping connection diagram submittal to piping contractor.

D. Field Quality Control: Start-up condensing units and heat pumps units in accordance with manufacturer’s start-up instructions. Test controls and

demonstrate compliance with requirements. Work with Division 23 System Commissioning, Testing and Balancing Test and Balance contractor in this work.

END OF SECTION 232300

SECTION 233100 - DUCTWORK

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.2 SUMMARY:

A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork required for the project include the following:

1. Rectangular
2. Round

C. Exterior Insulation of metal ductwork is specified in other Division-230700 sections and is included as work of this section.

D. Refer to other Division-230700 sections for exterior insulation of metal ductwork; not work of this section.

E. Refer to other Division-233000 sections for ductwork accessories; not work of this section.

F. Refer to other Division-23 sections for fans and air handling units; not work of this section.

G. Refer to other Division-230900 sections for mechanical controls; not work of this section.

H. Refer to other Division-233713 sections for louvers; not work of this section.

I. Refer to other Division-234116 sections for filters; not work of this section.

J. Refer to other Division-233713 sections for grilles and diffusers; not work of this section.

K. Refer to other Division-230593 sections for system commissioning, testing and balancing; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal ductwork systems work similar to that required for project.

1. The installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

2. All workmen on the project shall carry state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for metal ductwork materials and products.

B. Shop Drawings: Submit scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and space relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

C. Record Drawings: At project closeout, submit record drawings of installed metal ductwork and ductwork products, in accordance with requirements of General Conditions.

D. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Standards: Comply with SMACNA "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.

2. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1 "Duct Construction", for fabrication and installation of metal ductwork.

3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems".

4. International Building Code/International Mechanical Code: Comply with all

sections pertaining to mechanical work.

B. Field Reference Manual: Have available for reference at project field office, copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART II - PRODUCTS

2.1 DUCTWORK - GENERAL:

A. Standards: All duct fabrications shall comply with standards and techniques detailed by SMACNA "Duct Construction Manuals" for the appropriate pressure class, and with the ASHRAE Handbook, 1988 edition, Chapter 1, Duct Construction

B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lock forming quality, with G 90 zinc coating in accordance with ASTM A 525; mill phosphatized for exposed locations.

C. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting. Installation of exposed ductwork shall be laid out in advance and submitted for review. Ductwork shall be hung straight and uniform, points shall be true, and seams shall show continuity.

D. Stainless Steel Materials: Fabricate of Type 304 SS or Type 316 SS stainless steel sheet complying with ASTM A-167 with all welded joints and seams. Provide polished No. 4 satin finish for all hoods and duct exposed to view, No. 1 finish elsewhere. Protect finished surfaces with mill applied adhesive protective paper through fabrication and installation.

2.2 FITTINGS AND FABRICATION:

A. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15^{o} change of direction per section. Unless specifically detailed otherwise, use 45^{o} lateral and 45^{o} elbows for branch take-off connections. Where 90^{o} branches are indicated, provide conical type tees.

B. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30^{o} for contracting tapers and 20^{o} for expanding tapers.

C. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Duct Accessories' for accessory requirements.

D. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.

E. Offset, transition, and adapt ductwork to structural obstacles and work of other trades in a coordinated effort. Layout work to avoid conflict with piping, etc. With review of conditions, teardrop around conflicting piping, lights, etc., all at no added cost to the owner.

2.3 DUCT PRESSURE CLASSIFICATIONS:

A. For all VAV systems, which include but are not limited to

1. From fan discharge to air terminal unit: medium pressure ductwork, 10" w.g.

2. Rectangular supply air ductwork from air terminal unit, rectangular and round ductwork: Low pressure rectangular ductwork, 3" w.g.

3. All low pressure round supply air ductwork exposed to view; spiral lock seam, 3" w.g.

4. Branch round supply air ductwork runout from rectangular ductwork to diffuser: Low pressure round ductwork, 1" w.g.

5. Outside air ductwork and plenums, 10" w.g.

6. Relief air plenums, 3" w.g.

B. Low pressure exhaust ductwork and ventilation systems, which include but are not necessarily limited to exhaust fan systems and ventilation systems.

1. Low pressure rectangular ductwork, 3" w.g. Increase metal gauge by 2 (i.e., 20 to 18) for all sizes.

2.4 LOW PRESSURE ROUND DUCTWORK: (1" SMACNA Pressure Class)

A. Round type ductwork for use on low velocity supply systems (1200 fpm maximum), low pressure (0.75" maximum duct pressure), shall be fabricated on 26 gauge galvanized steel sheets with snap-lock longitudinal seams and crimped and beaded joins.

B. All end joints shall have at least three screw fasteners and shall be wrapped airtight. Transverse and longitudinal seams shall be sealed with duct cement. Elbows and fittings shall provide smooth air flow patterns and have a neat appearance.

C. Use factory fabricated elbows of the multi-sectional adjustable type.

2.5 LOW PRESSURE RECTANGULAR DUCTWORK: (3" SMACNA Pressure Class)

A. Rectangular ductwork for use on supply systems up to 2" maximum duct static pressure and 2000 fpm maximum duct velocity shall be constructed of galvanized steel using

construction for nominal 3" SMACNA rated systems. Seal all transverse joints with duct cement.

B. Use radius elbows or turning vanes with extended trailing edge. Use a true 1-1/2 time 45° tapping takeoffs with downstream balance damper.

C. Duct dimensions are inside clear. Increase for acoustical lining.

D. For rectangular exhaust ducts, increase metal gauge by 2 (i.e. 20 to 18) for all sizes. Seal all joints.

2.6 MEDIUM PRESSURE DUCTWORK: (10" SMACNA Pressure Class)

A. General: At Installer's option, provide factory-fabricated duct and fittings, in lieu of shop-fabricated duct and fittings.

B. Round Ductwork: Construct of galvanized sheet steel complying with ASTM A 527 by the following methods and in minimum gauges listed.

Diameter	Minimum Gauge	Method of Manufacture
3" to 14"	26	Spiral Lockseam
15" to 26"	24	Spiral Lockseam
27" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam
51" to 60"	18	Spiral Lockseam
Over 60"	16	Longitudinal Seam
60" to 84"	18	Spiral Lockseam

Provide locked seams for spiral duct; fusion-welded butt seam for longitudinal seam duct.

C. Round Duct Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams. Mitered elbows shall be of at least 5 piece construction with R/D ratio of 1.5. All branch takeoffs shall be a true 45º takeoff having an overall throat width at the main duct connection of 1-1/2 times the sizes of the branch duct.

Diameter	Minimum Gauge
3" to 36"	20
38" to 50"	18
Over 50"	16

D. Flat-Oval Ductwork: Construct of galvanized sheet steel complying with ASTM A 527, of spiral lockseam or longitudinal seam construction, in minimum gauges listed.

Maximum Width	Minimum Gauge Spiral	Longitudinal
Under 25"	24	22
25" to 48"	22	20
49" to 70"	20	18
		Stiffener Inserts 4'-0" on Center

E. Flat-Oval Duct Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams.

Maximum Width	Minimum Gauge
Under 37"	20
37" to 50"	18
Over 50"	16

F. Double wall Internally Insulated Duct and Fittings: Construct with outer pressure shell, 1" or 2" thick (as indicated on drawings) insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, use longitudinal seam for over 59", in minimum gauges listed. Use where indicated on drawings.

Equivalent to United McGill "Acoustic-K27".

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 12"	26 gauge	24 gauge
13" to 24"	24 gauge	24 gauge
25" to 34"	22 gauge	24 gauge
35" to 48"	20 gauge	24 gauge
49" to 58"	18 gauge	24 gauge
Over 59"	16 gauge	20 gauge

G. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell. Construct fittings to close tolerance with ductwork.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 34"	20 gauge	20 gauge
36" to 48"	18 gauge	20 gauge
Over 48"	16 gauge	20 gauge

H. Field joints shall be sealed using duct cement. Duct sections and fittings shall be held in place at joints with sheet metal screws 6" on centers. Simple coating of joint surfaces with mastic prior to joining is not acceptable (SMACNA Std. P.1-11).

I. Oval ductwork shall be installed where called for on the plans and where required to conform to tight space requirements encountered during construction. The contractor shall furnish transition pieces as required. Oval ductwork shall have equivalent capacity to the round duct.

At the Contractor's option odd inch diameter round ducts may be increased in size to the next larger even inch providing space considerations are accommodated and all related conditions are resolved by the contractor.

2.7 FACTORY DUCT:

A. Extent of Work: Provide factory duct at connections to air terminal units, at runouts to grilles and diffusers, at points of round to round flexible connections (see also "Flexible Connections") and at other locations indicated or required.

B. Prohibited Material: Do not use single wire helix ducting with vinyl or plastic liner of any type.

C. Factory Duct Non-corrosive Environments: Woven fiberglass fabric impregnated with vinyl or neoprene clamped in a continual helix of aluminum or cold rolled steel. U.L. listed for Class 1 duct, compliant with NFPA 90A and 90B, pressure rated to 12" w.g., equivalent to:

D. Non-insulated: Wiremold 57; Flexmaster Type N145

E. Insulated: Flexmaster Type 4; Thermaflex M-KC

F. Installation: Follow manufacturers instructions. Use stainless steel or nylon band clamping rings. In general, do not use lengths in excess of 3 feet. Make bends only in long radius format. Support duct to avoid droops and kinks.

2.8 MISCELLANEOUS DUCTWORK MATERIALS:

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Runout Fittings: Runout fittings shall be used to make round to rectangular duct connections. Use 45^{o} time and a half square to round fittings. Provide with locking quadrant dampers where balance is involved. Provide with insulation guard where insulated duct is involved. Manufacturer: Hercules.

C. Duct Sealing Compound: Duct sealing compound shall be 3M brand number EC-750 or Duro-Dyne S-2. This material shall be used in making up duct joints or in water proofing, caulking plenums, etc.

D. Acoustical Lining: Acoustical lining in ducts shall be 1" thick, 1-1/2 pound density, coated, flexible glass fiber type, set in adhesive and impaled on weld studs spaced not more than 12" on centers and secured with lock washers. Airstream surface faced with black coated matte. Acoustical lining shall completely line the ducts. Lining shall have a fire and smoke hazard rating not exceeding 20-50-50. Owens-Corning, Johns-Manville, Certainteed.

1. All joints, edges and/or surface breaks in the coating of the acoustical lining shall be pointed up to a smooth surface with adhesive.

E. Duct Liner Adhesive: Comply with ASTM C 916 "Specifications for Adhesives and Duct Thermal Insulation".

F. Duct Liner Fasteners: Comply with SMACNA HVAC Duct Construction Standards, Article S2.11.

G. Duct Cement: Non-hardening migrating mastic or liquid neoprene based cement (type applicable for fabrication/ installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork. DP1010, or Polymetrics

H. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

PART III - EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF METAL DUCTWORK:

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.

All necessary allowance and provisions shall be made in the installation of sheet metal ducts for the structural conditions of the building, and ducts shall be transformed or divided as may be required. Whenever this is necessary, the required area shall be maintained. All of these changes, however, must be approved and installed as directed at project. During the installation, the open ends of ducts shall be protected to prevent debris and dirt from entering.

B. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

D. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures. Maintain clearances above of and in front of

electrical panels.

E. 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 gage as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate.

1. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate, in accordance with requirements of Section "Firestopping".

F. Ducts At Structural and Architectural Penetrations: Where ducts are shown connecting to or passing through concrete, gypsum board, masonry openings and along edges of all plenums at floors and walls, provide a continuous 2" x 2-1/8" galvanized angle iron which shall be bolted to the construction and made airtight to the same by applying caulking compound. Sheet metal in these locations shall be bolted to the angle iron. Round high velocity ducts in vertical chases shall be supported with rolled angle rings. Close openings between duct and structure.

G. Cross Breaking: Rectangular sheet metal ducts shall be cross broken on the four sides of each 4-foot panel. All vertical and horizontal sheet metal barriers, duct offsets, elbows, as well as 4-foot panels of straight sections of ducts shall be cross broken. Cross breaking shall be applied to the sheet metal between the standing seams or reinforcing angles; the center of cross break shall be of the required height to assure surfaces being rigid.

H. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

I. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

1. Related to final installation cleanliness, damp wipe all ductwork on installation. Cap open duct ends, cover fan inlets, vacuum fan plenums and related installation before starting fans. Run fans only with filters in place.

3.3 INSTALLATION OF DUCT LINER:

A. General: Install duct liner in accordance with SMACNA HVAC Duct Construction Standards.

As indicated on the drawings, supply, return and exhaust air ductwork shall be lined with acoustical insulation.

In all cases outside air ductwork shall be lined with 2” thick 1-1/2 lb. density acoustical lining unless indicated differently on drawings, i.e. requiring Type 2 plenum.

3.4 INSTALLATION OF FLEXIBLE DUCTS:

A. Maximum Length: For any duct run using flexible ductwork, do not exceed 3'-0" extended length. No elbows allowed.

B. Installation: Install in accordance with Section III of SMACNA's "HVAC Duct

Construction Standards, Metal and Flexible".

3.5 HANGERS AND SUPPORTS:

A. It is essential that all ducts shall be rigidly supported. Hangers for low velocity ducts up to 18" in width shall be placed on not more than 10' centers.

Low velocity ducts 19" through 35" in width and greater shall be supported on not more than 5' centers. Where vertical ducts pass through floors or roofs, heavy supporting angles shall be attached to ducts, and to structure. Angles shall be of sufficient size to support the ductwork rigidly and shall be placed on at least two sides of the duct.

B. Construct hangers for rectangular ductwork from galvanized iron l" x 1/16". Hangers shall extend down the sides of rectangular ducts the full depth of the duct and shall be bent underneath the duct 2". Hangers shall be secured to the duct using sheet metal screws or rivets of appropriate sizes on 6" centers, but not less than two screws in the side and one in the bottom of each hanger.

C. For rectangular ducts 36" and greater in width construct hangers from galvanized iron 1-1/2" x 1/16". Hangers shall be installed and secured to duct as described in Paragraph B.

3.6 SUPPORTING DAMPERS: Parallel and opposed blade motor operated dampers shall be supported by reinforcing the ductwork or sheet metal walls at the damper locations to carry the weight of the dampers and the force exerted on the dampers due to air pressure, or shall be supported independent of ductwork from the ceiling or floor, as conditions at the site determine.

3.7 CONNECTIONS: Connections of high velocity supply and exhaust ducts, fittings, and high velocity mixing boxes shall be made airtight by coating joints with Minnesota Mining Co. Mastic, Type EC-800, Benjamin Foster, Sheet Metal Products Co., or approved equal, before joining, and then sealing the joint with one layer of "Glass-Fab" reinforcing tape set in a coating of the above compound. Tape and sealant shall not exceed a flame spread of 25 or a smoke development of 50.

3.8 WELDED JOINTS: Welded ductwork shall have either an angle or a piece of 1/8" steel bar behind each weld to allow laying of a neat and continuous bead.

3.9 AESTHETIC LAYOUTS: Contractor shall locate all diffusers, grilles and other exposed items in such a manner as to fit symmetrically in any grid system or other aesthetic architectural or lighting pattern. Refer to reflected ceiling plans and electrical lighting layouts for additional information. Provide duct offsets or extensions as required to make a proper installation.

A. Close or cap all duct ends. Use auxiliary blower with air flow meter to establish a duct pressure equivalent to the duct pressure class. Inspect all joints in duct system and seal all identifiable leaks.

B. In areas with exposed ductwork, contractor shall limit the number of duct connections to as few as possible. Where possible provide duct down stream of VAVR boxes as one continuous spiral round or oval (as indicated on drawing) duct. Exposed ductwork joints shall be made with the Ductmate, Spiralmate connection system or equal by approved manufacturer. Connections shall be clean with the ring tightening bolt on the top of the duct and the excess bolt length cut off. Joint locations shall be uniform, ie. in adjacent

parallel duct runs the joints shall be in the same location for each duct run.

3.10 FIELD QUALITY CONTROL:

A. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Air leaks which are in excess of that required to bubble the soap suds (that is, actually blow the suds away) shall be sealed by additional taping and caulking to reduce the leakage to a rate not to exceed slow bubbles forming. Repair leaks and repeat tests until total leakage conforms with Chart of Figure 4-1, Seal Class A, and Leakage Class 3 for round/oval, 6 for rectangular.

3.11 EQUIPMENT CONNECTION:

A. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.12 ADJUSTING AND CLEANING:

A. Clean ductwork internally of dust and debris, as follows: Before the ceilings are installed, with filters in place, operate the fans at full capacity to blow out dirt and debris from ducts. If it is not practical to use the main supply blower for this test, the ducts may be blown out in sections by a portable fan.

B. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

C. Balancing:

1. Refer to Division-23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. However, the Sheet Metal Contractor shall participate fully in this work. Seal any leaks in ductwork that become apparent in balancing process.

2. If specified conditions cannot be obtained due to deficiencies in equipment performance or improper installation or workmanship, the Mechanical Contractor and his subcontractors shall make any changes necessary to obtain the specified conditions.

END OF SECTION 233100

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SECTION 233300 - DUCTWORK ACCESSORIES

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 SUMMARY:

A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork accessories required for project include the following:

1. Dampers.
   a. Low pressure manual dampers.
   b. Control dampers.
2. Turning vanes.
3. Duct hardware.
4. Flexible connections.

C. Refer to other Division-23 sections for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC

Duct Construction Standards, Metal and Flexible".

2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".

4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store accessories inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART II - PRODUCTS

2.1 DAMPERS:

A. Control dampers are furnished by this Section and installed by this Section. Dampers shall be supported, plenum openings shall be reinforced, the entire assembly shall be sturdy and operate smoothly. Install dampers to direct outside and return air into each other for mixing. Control dampers for relief air, return air, ventilation air, exhaust air, outside air, and supply air. Low leakage type with spring loaded side seals, inflatable butyl or neoprene fabric edge seals, bronze or teflon bearings, reinforced extruded aluminum airfoil blades, aluminum frame. Action as indicated on drawings. Air leakage not to exceed 5 CFM per square foot at 4" upstream static pressure.

1. Ruskin CD-50
2. Greenheck VCD-43
3. Tamco 1000

B. Control dampers for balance only where tight shutoff is not critical are to be furnished and installed by this Section. 6" galvanized blade, poly foam blade seals, flexible metal jamb. Parallel blade operation.

1. Ruskin CD-35
2. Greenheck
3. Tamco

2.2 TURNING VANES: Turning vanes shall be installed in all square elbows. Turning vanes shall be single blade with trailing edge. Turning vane spacing shall be per SMACNA. Each blade shall be tack welded or crimped to the carrier frame to prevent rattling.

2.3 DUCT HARDWARE:

A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, cover, for instrument tests. Ventlok No. 699 closures shall be provided and installed for each test hole, with sufficient neck length to penetrate the insulation.

2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork. (Bare duct - Ventlok 620, 635; Insulated duct - Ventlok 627, 628, 637, 638, 629.)

B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:

1. Ventfabrics, Inc.
2. Young Regulator Co.

PART III - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES:

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install hand operated volume dampers at locations and of sizes shown. Volume dampers shall be controlled by heavy duty locking quadrants mounted on the outside of the duct. Where ducts are insulated, the damper rod shall be extended and the operator shall be mounted on the outside of the insulation. Butterfly dampers may be constructed by the Sheet Metal Contractor. All multi-blade hand dampers shall be the product of one of the manufacturers listed in the Contract Documents. All operator fittings shall be heavy duty commercial grade.

C. Install turning vanes in square or rectangular 90 degree elbows in supply and exhaust air systems, and elsewhere as indicated.

D. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL:

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

3.4 ADJUSTING AND CLEANING:

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

1. Final positioning of manual dampers is specified in Division- 23 section "Testing, Adjusting, and Balancing".

2. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 EXTRA STOCK:

A. Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION 233300

SECTION 233713 - AIR OUTLETS AND INLETS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of outlets and inlets required for project include the following:

1. Return air grilles.
2. Louvers.

C. Refer to other Division-23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.

D. Refer to other Division-23 sections for balancing of air outlets and inlets; not work of this section.

E. Refer to other Division sections for louvers, not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal ductwork systems work similar to that required for project.

1. The Installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

2. All workmen on the project shall carry state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

B. Samples: 3 samples of each type of finish furnished.

C. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".

2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".

4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART II - PRODUCTS

2.1 GRILLES AND DIFFUSERS:

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and

velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Volume Control Dampers: Provide duct mounted dampers of the externally adjustable opposed blade type where more than one grille or register is on a common duct. Provide access to each damper adjustment.

D. Sound Level: The diffuser or grille generated noise shall not exceed the following sound power level curve at a point five feet away form the diffuser or grille.

1. Work Rooms: NC 35-40
2. Storage: NC 35-40

E. Manufacturers: Subject to compliance with requirements, provide grilles and diffusers of one of the following:

1. Krueger
2. Titus
3. EH Price

F. Types: Provide grilles and diffusers of type, capacity, and with accessories and finishes as listed on grille and diffuser schedule and as specified herein.

G. Grilles and Diffusers:

1. Surface Return Grille (R-1): Krueger Series SH Frame 21, Titus TDC, for installation in Gypsum Board Ceiling, constructed of steel, inner core removable, square, outer core -beveled for surface mounted installation, finish - white baked enamel, size as indicated on the drawings.

2.2 LOUVERS:

A. Extent of Work: At air openings in the outside wall where indicated on drawings, install AMCA rated drainable stationary extruded aluminum 6" deep weather louvers.

B. Material: Blades shall be on 3-1/2" centers with integral downspouts to drain the water from the louver blades. Stationary louvers shall pass 1000 fpm free area velocity with less than 0.2" static pressure drop and shall carry less than .03 ounces of water per square foot when tested in accordance with AMCA Standard 500. Install stainless steel 1/2” mesh screens on interior face and louver.

1. Louvers shall be equal to Ruskin ELF6375DX
   a. American Warming and Ventilating,
   b. Louvers and Dampers,
   c. Ruskin
   d. Greeheck
   e. Pottorff

2. Coordinate with the Architectural details for type of flange and structural details for actual wall opening sizes.

3. Color as selected by Architect.

C. Contractor must coordinate louver size, flange type, and construction with structural and architectural openings to assure fit and appearance. Louvers shall be one piece.

PART III - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

END OF SECTION 233713

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SECTION 237300 - PACKAGED AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To

1. Furnish and install packaged modular air handling units and associated components as described in Contract Documents.

B. Related Sections

1. Section 23 0900 - Mechanical Control Systems
2. Section 23 0000 - General Mechanical Requirements
3. Section 23 0513 - Drives and Electrical Requirements for Mechanical work
4. Section 23 2000 - General Pipes and Fittings
5. Section 23 3100 - Ductwork

1.2 SUBMITTALS

A. Product Data

1. Indicate dimensions, weights, capacities, fan capacities, fan performance, motor electrical characteristics, casing construction details, wiring interconnections, gauges, and finishes of materials.
2. Indicate filter sizes and quantities, and filter frames.
3. Provide coil selection work sheets showing proper consideration for altitude, air density, and fouling factor.
4. Manufacturer installation instructions.
5. Fan curves with specified operating points clearly plotted.
6. Sound power levels for air handling unit(s) at scheduled conditions.
7. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts list, and wiring diagrams.
8. Provide full selection and description materials for Variable Frequency Drive (VFD) and wiring furnished as part of the AHU package.

B. Record Documents

1. Show unit configuration in the direction of airflow.
2. Indicate assembly and unit dimensions.

1.3 QUALITY ASSURANCE

A. Certification Requirements

1. Certify air handling unit capacity, static pressure, fan speed, brake horsepower, and selection procedures in accordance with AMCA 210 and ASHRAE Standard 51

2. Certify air coils capacities, pressure drops and selection procedures in accordance with ARI 410-87.

3. Certify sound power levels for air handling unit(s) at scheduled conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver air handler to site on factory-installed 5 or 6 inch high base rail. Furnish in demountable sections to accommodate installation in the building.

1.5 MAINTENANCE

A. Extra Materials - In addition to the construction set, provide one additional set pleated media filters for each air handler.

1.6 WARRANTY

A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 – PRODUCTS

2.1 AIR HANDLING UNIT AHU – 9510

A. Acceptable Manufacturers:

1. The approved manufacturer shall be Trane, with pre-approved alternates considered. Manufacturers not pre-approved must obtain pre-approval in writing from consulting engineer prior to bid day. Alternates must comply with all performance and features as called for in this specification. Job awarded on basis of specified equipment. Alternate will be evaluated and considered after job is awarded.

2. Manufacturer must clearly define any exceptions made to Plans and Specifications. Any deviations in layout or arrangement shall be submitted to the consulting engineer prior to bid date. Acceptance of deviation(s) from specifications shall be in the form of written approval from the consulting engineer. The Mechanical Contractor is responsible for expenses that occur due to exceptions made.

B. General:

1. Unit layout and configuration shall be as defined in project plans and schedule.

C. Unit Casing:

1. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 125-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around the full perimeter to prevent air leakage. The contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

2. All panels shall be 2-inch double wall construction to facilitate cleaning of unit interior. Casing deflection shall not exceed .005-inch deflection per linear inch under negative or positive pressure, up to unit 6" of pressure.

3. The unit floor shall be of sufficient strength to support a 300-lb load during maintenance activities, and shall deflect no more than .005-inches when sitting on a support structure.

4. Panel insulation shall provide a minimum thermal resistance (R) value of 13 ft^2*h*F/Btu throughout the entire unit. Insulation shall completely fill the panel cavities in all directions so that no voids exist and settling of insulation is prevented. Panel assembly shall comply with NFPA 90A.

5. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

6. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

D. Access Doors:

1. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

2. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

3. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

4. Handle hardware shall be designed to prevent unintended closure.

5. Access doors shall be hinged and removable without the use of specialized tools to allow.

6. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.

E. Primary Drain Pans:

1. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. Drain pan shall be polymer.

2. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.

3. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.

4. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

F. Supply Fan:

1. Fan section shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.

2. Provide fans of type specified on the schedule. Belt drive fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM.

3. Belt drive fans with integral frame motors shall be internally isolated to inhibit noise and vibration through the ductwork and building structure. A flexible connection shall be installed between the fan and unit casing to ensure complete isolation. Fan and motor shall be internally isolated with spring isolators. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

4. Belt-driven fans shall be provided with self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9

G. Motors And Drives:

1. The motor, and drive for belt drive fan, shall be factory-installed and run tested. The motor for the belt driven fan shall be installed on a slide base to permit adjustment of belt tension. The slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have the motor field installed by the contractor. The contractor shall be responsible for all costs associated with installation of the motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.

2. The Integral horsepower motor shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.

3. Integral horsepower fan motor shall be heavy duty, open drip-proof operable at 460/60/3 volts, 60Hz, 3-phase. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.

4. All fan types utilizing integral horsepower motors, shall use 4-pole, 1800 rpm, motors, NEMA B design, with Class B insulation, capable of operating continuously at 104 deg F (40 deg C) without tripping overloads.

5. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

6. V-Belt drives for housed fans shall be 1100 rpm (1050 - 1150 variable) pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs and housed fans shall be fixed pitch.

7. All housed fans with motors 15 hp and larger shall be equipped with multiple belt drives.

8. Manufacturer shall provide for each unit with a housed fan a nameplate with the following information to assist air balance contractor in start up and service personnel in maintenance:

H. Coils:

1. Coil section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

2. Install coil such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

3. Coil shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

4. Construct coil casing of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

5. Coil shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be de-greased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

6. Refrigerant Cooling Coil

   a. Refrigerant suction and liquid connections shall penetrate through unit casing to facilitate refrigerant piping in the field.

b. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water. After testing, the insides of tubes shall be air dried, charged with dry nitrogen or dry air, and sealed to prevent contamination.

c. Refrigerant suction and liquid headers shall be constructed of copper tubing. Suction and liquid connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.

d. Tubes shall be 1/2 inch O.D., minimum .016 inch thick copper. Fins shall be aluminum.

e. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

I. Filters:

1. Provide factory-fabricated filter section of the same construction and finish as unit casings. The filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Construct doors in accordance with Paragraph 2.1.C. Provide fixed filter block offs as required to prevent air bypass around filters. Block offs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each unit size.

2. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule.

J. Dampers:

1. All dampers shall be internally mounted. Dampers shall be premium ultra-low leak and located as indicated on the schedule and plans. Parallel blade arrangement shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. The manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

K. Controls:

1. The controls shall be provided by others and field wired. Provide the Air Handling Unit with the necessary accommodation which will allow for this to take place.

L. Accessories:

1. Variable Frequency Drive (VFD)

a. Reference Section 230513 Paragraph 2.3 for description of VFD.

b. Warranty

1) The VFD shall be warranted by the manufacturer for a period of 42 months from date of shipment, or 36 months from start-up, whichever occurs first. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

c. The VFD shall be furnished by the AHU Vendor but shipped separately for mounting in the field.

PART 3 - EXECUTION

3.1 SHIPPING

A. Paper copies of the IOM shall also be shipped with the AHU.

B. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.

C. To protect equipment during shipment and delivery, all indoor units shall be stretch or shrink wrapped. The wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.

D. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.2 ON-SITE STORAGE

A. If equipment is to be stored for a period prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.3 FIELD EXAMINATION

A. The Mechanical Contractor shall verify that the mechanical room is ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.

B. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.

3.4 INSTALLATION

A. The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Owner and the Owner's selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.

B. The AHU manufacturer shall provide all screws and gaskets for joining sections in the field.

C. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:

1. All isolated components have had their shipping restraints removed and the components have been leveled.

2. On all field-joined units, that all interconnections have been completed, i.e., electrical wiring, piping, casing joints, bolting, welding, etc.

3. All refrigerant piping connections have been completed and tested.

4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.

5. All power wiring, including motor starters and disconnects, serving the unit has been completed.

6. All safety controls have been completed.

7. All dampers are fully operational.

8. All shipping materials have been removed.

9. Clean filter media has been installed in the units.

3.5 LEVELING

A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

3.6 FINAL INSPECTION AND START UP SERVICE

A. After the Mechanical Contractor has provided all refrigerant piping connections, ductwork connections, the Mechanical Controls Contractor has installed the controls, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor shall then perform startup of the equipment.

B. The Automatic Temperature Control (Building Direct Digital Control) Contractor shall be scheduled to be at the job site at the time of the equipment's start up.

C. The Mechanical Contractor, shall perform the following tests and services and submit a report outlining the results:

1. Record date, time, and person(s) performing service.

2. Check all motor and starter power lugs and tighten as required.

3. Verify all electrical power connections.

4. Conduct a startup inspection per the AHU manufacturer's recommendations.

5. Record fan motor voltage and amperage readings.

6. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.

7. Check fan for excessive vibration.

8. If so equipped, check V belt drive for proper tension and alignment. Tighten the belts in accordance with the AHU manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU manufacturer.

9. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.

10. Disengage all shipping fasteners on vibration isolation equipment.

11. Secure all access doors to the fan, the unit and the ductwork.

12. Switch electrical supply "on" and allow fan to reach full speed.

13. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.

14. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.

15. Check all control sequences.

END OF SECTION

SECTION 238241 - ELECTRIC UNIT HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install electric heaters as described in Contract Documents.

B. Related Sections:
   1. Section 230000: General Mechanical Requirements.
   2. Division 26: Electrical service and connections.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Unit heaters shall be UL listed and comply with NEC requirements.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Electric Duct Heater (EDH-1)
   1. General: Provide duct heater in location as indicated and of capacity and style and having accessories as scheduled.
   2. Unit shall be complete factory assembled, wired, and tested. Ready for installation and connection to electrical power source and control package.
   3. Approvals – Heaters and panelboards (if required) shall meet the requirements of the National Electrical Code and shall be listed by Underwriters Laboratories for zero spacing between the duct and combustible surfaces and for use with air conditioning equipment.
   4. Heating elements shall be open coil, 80% nickel, 20% chromium, Grade A resistance wire. Type C alloys containing iron or other alloys are not acceptable. Coils shall be machine crimped into stainless steel terminals extending at least 1” into the airstream and all terminal hardware shall be stainless steel. Coils shall be supported by ceramic bushings staked into supporting brackets.
   5. Heater frame and terminal box shall be corrosion resistant steel. Unless otherwise indicated, the terminal box shall be NEMA 1 type construction and shall be provided with a hinged, latching cover and multiple concentric knockouts for field wiring.
   6. The heater shall be furnished with a disc type, automatic reset thermal cutout for primary over-temperature protection. The heater shall also be furnished with disc type, load carrying manual reset thermal cutouts, factory wired in series with heater stages for secondary protection. Heat limiter or other fusible overtemperature device is not acceptable.
   7. Heater shall be rated for the voltage, phase, and number of heating stages indicated in the schedule. All three-phase heaters shall have equal, balanced, three-phase stages. All internal wiring shall be stranded copper with 105°C insulation and shall be terminated in crimped connectors or box lugs.

8. Terminal blocks shall be provided for all field wiring and shall be sized for installation of 75°C copper wire rater in accordance with NEC requirements.
9. Provide duct heater with the following Special Features:
    a. Airflow switch for negative pressure operation
    b. Insulated terminal box.
    c. Dust-tight terminal box
    d. Insulated duct construction. (>1" ≤6" thick lining)
    e. Pressure plate
    f. Protective screen(s); both sides
    g. Transformer primary fusing (standard for Class I)
    h. 24 VA control circuit voltage.
    i. "Low Airflow" pilot light
    j. "Heater On" pilot light
    k. Each "Stage On" pilot light(s)
    l. Fan relay.
    m. Remote enable heater operation.
    n. Step controller
    o. Linear limit automatic rest thermal cutout
    p. 25 watts per square inch resistance coils
10. Provide with integral disconnect.
11. Manufacturer: Subject to compliance with requirements, provide unit heaters from one of the following:
    a. Qmark
    b. Reznor
    c. Indeeco
    d. Modine
    e. Markel
    f. Berko
    g. King Electric

PART 3 EXECUTION

A. Install Duct Heater in accordance with manufacturer's instructions in location as indicated on the Mechanical Floor Plans.

B. Coordinate with the electrical and controls contractors to provide power and controls for the Duct Heater.

END OF SECTION

SECTION 237500 - REFRIGERANT AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Refrigerant air coils.

B. Related Requirements:

1. Section 238241.00 "Electric Resistance Air Coils" for electric air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.6 FIELD CONDITIONS

A. Altitude above Mean 4500 Feet.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure: 449 psig.

D. Select cooling coil for no moisture carryover at design conditions. Provide moisture eliminators on discharge face of cooling coil if necessary to eliminate moisture carryover.

E. Capacities and Characteristics:

a. Reference Equipment Schedule.

2. Refrigerant Side:

a. Refrigerant Type: R-410A
b. Saturated Suction Temperature: 45°F

2.2 REFRIGERANT AIR COILS

A. Source Limitations: Obtain refrigerant coils from single source from single manufacturer.

B. Description: Plate fin coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into plate fins. Coils are to be counterflow circuited and equipped with pressure-type distributors, and distributor tubes are to be of equal length, to ensure equal distribution of refrigerant to each circuit.

C. Circuiting: Indicated on Drawings

D. Tubes:

1. Material: **Copper**
2. Nominal Diameter: Selected for performance indicated.
3. Nominal Wall Thickness: As required by performance, minimum of 0.035 inch thick.
4. Return Bends: 180-degree bends; material and nominal diameter to match tubes.
5. Brazing: High-temperature brazing alloy with not less than 5 percent silver.

E. Fins:

1. Type: Plate.
2. Materials:

a. Aluminum: 0.0075 inch

3. Spacing: Maximum 12 fins per inch (2.1 mm)
4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
5. Configuration: Fin type as required by performance requirements
6. Fin and Tube Joint: Silver brazed.

F. Headers:

1. Material: Seamless copper
2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch (3 mm).
3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
4. Protect openings to prevent entry of dirt into coil.

G. Casings and Tube Sheets:

1. Depth: Extend coil casing and tube sheets a minimum of 1/2 inch beyond face of fins on both entering and leaving sides.
2. Materials:

    a. Stainless steel, Type 304 No. 2D finish.
    b. Galvanized steel, G90 (Z275) coating.
    c. Copper.
    d. Aluminum.

3. Top and Bottom Casings:

    a. Flange face minimum of 1-1/2 inches double-flange edge for rigidity and ease of removal with secondary flange face minimum of 1/2 inch
    b. Thickness: Minimum of 16 gauge thick.

4. End Tube Sheets:

    a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
    b. Flange face minimum of 1-1/2 inches
    c. Thickness: Minimum of 16 gauge thick.

5. Intermediate Tube Sheets:

    a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
    b. Space intermediate tube sheets a maximum of 48 inches o.c. and locate to provide equal spacing between tube sheet across coil tube length.
    c. Flange face minimum of 1/2 inch
    d. Thickness: Minimum of 16 gauge thick.

H. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

I. Hardware: Use hex-head bolts, nuts, and washers constructed of [**Type 304**] [**or**] [**Type 316**] stainless steel.

2.3 MATERIALS

A. Aluminum: ASTM B209 (ASTM B209M).

B. Copper Sheet: ASTM B152.

C. Copper Tube: ASTM B75/75M annealed temper or ASTM B280 drawn temper.

D. Galvanized Steel: ASTM A653/A653M.

E. Stainless Steel: ASTM A240/A240M.

F. Steel: ASTM A53/A53M.

2.4 SOURCE QUALITY CONTROL

A. Refrigerant Coils: Factory tested using dry nitrogen while coil is completely submerged underwater to design pressure indicated, but not less than 400-psig internal pressure.

B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless steel drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect refrigerant piping according to Section 232300 "Refrigerant Piping."

END OF SECTION 238216.13

DIVISION 26
ELECTRICAL INDEX

SECTION 25 05 00 – ELECTRICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.1 SCOPE

A. This Section consists of the Electrical General Requirements and related items necessary to provide complete and operational electrical system(s) indicated within the Contract Documents.

1.2 APPLICABLE SECTIONS AND REQUIREMENTS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and Addenda, applicable drawings, and the technical specifications herein shall apply to all work specified herein.

B. The CONTRACTOR shall comply with the specifications and accompanying drawings which describe and provide for the furnishing, delivering, installing, testing, and placing in satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete electrical system for power distribution, control, lighting, and auxiliary systems.

C. State Licensed Contractor - All contractors must have a current state contracting license. The CONTRACTOR shall be licensed as such in the CONTRACTOR state of origin and in the state where the work is performed.

D. The electrical contractor shall have a licensed Master Electrician assigned to direct the electrical work and to coordinate work with the General Contractor and other trades. Furthermore, a licensed journeyman electrician shall be assigned to supervise the actual performance of all electrical work specified herein.

E. The licensed journeyman assigned to supervise the performance of all electrical work, shall be required to be on the job site at all times, while electrical work is being performed.

1.3 CONTRACT DOCUMENTS

A. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. Each is complementary and requirements shown, written or reasonably inferred there from one is considered as written, shown or implied in all. In the event work is called for in more than one place and is of conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

B. The drawings are diagrammatic, intended to indicate the general scope and locations of the work to be installed and are not to be considered as complete in every detail, but shall be followed as closely as actual construction and work of other contractors will permit.

C. Data given herein and on drawings are as exact as could be secured, but their extreme accuracy is not guaranteed. Drawings and specifications are for the assistance and guidance of the CONTRACTOR; but exact locations, distances, and levels will be governed by actual conditions, and the CONTRACTOR is to verify all dimensions given on the drawings, and to report any discrepancy or inconsistency to the ENGINEER before commencing with the work.

D. The CONTRACTOR shall install all work indicated and/or specified herein, complete to perform the function intended without additional cost. Raceway and conductors to panels from devices referred to as "home runs" are indicated by pointing in the general direction of panels. Construction shall continue such circuits to the panels as though the routes were completely indicated. Home runs shall be installed from devices to panels as indicated.

E. Deviations from the drawings required to make work of this contract conform to actual conditions as constructed, or as to work of other contractors, shall be made by the CONTRACTOR at his expense. The ENGINEER reserves the right to make minor changes in the location of equipment and devices without additional charges.

F. The CONTRACTOR shall familiarize himself with the architectural, structural, and civil/mechanical drawings and shall study drawings and details so that equipment will be properly located and readily accessible. If any conflicts occur necessitating departures from the contract drawings, details of departures and reasons therefore shall be submitted for prior approval.

G. In any case and at any time, a change in material or location is made necessary by CONTRACTOR's failure to take into account obstacles or the installation of other trades shown, whether on electrical drawings or other drawings, in existence at the time bids were received, such changes shall be made without charge to OWNER.

H. Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Where drawings are required for these purposes or have to be made from field measurements, they shall be prepared by the CONTRACTOR, Shop Drawings of various contractors shall be coordinated to take into account all obstacles that will interfere with the installation.

I. Every attempt has been made to indicate the installation and wiring requirements for all equipment to be installed. However, it shall be the CONTRACTOR’s responsibility to coordinate with equipment shop drawings and make adjustments necessary including; power and control wiring sizes and counts, breaker sizes, rough-in locations, etc. for actual equipment provided. The contractor shall provide in his bid the conductors and conduits required for the equipment to be installed. The contractor shall reference the mechanical drawings, the P&ID drawings, the control diagrams, the control drawings, the power drawings, the one line diagrams and all schedules. The contractor shall at his expense provide the conduit and conductors for the equipment installation for a complete and functional system.

J. Every attempt has been made in the drawings to indicate the general installation requirements for the power and control connections for the equipment indicated. However, equipment requirements vary from manufacturer to manufacturer and from date to date for equipment. The responsibility to coordinate the exact requirements of all equipment and install the required systems for these systems shall belong to the contractor, at his expense. No additional costs to the owner shall be incurred for the contractor's failure to coordinate these equipment requirements at the time of bid.

K. Electrical drawings are diagrammatic in nature and are not intended to show shop drawing style connections, equipment installation coordination or exact conduit and conductor sizes or counts. The contractor shall at his expense coordinate and provide necessary electrical and control components for a complete and functional system. If any conduit, equipment schedule, sizing, capacities, counts, lengths are unclear at the time of bidding or if conflicts exist on the drawings or in the specifications, the owner reserves the right for the installation of the more expensive or the more involved at no additional cost to the owner.

1.4 INFORMATION FOR ENGINEER

A. Submit the required information in accordance with the General Conditions, Section 26 0500, and the following requirements.

1. The CONTRACTOR shall check all shop drawings for conformance with Contract Documents before submitting. The CONTRACTOR shall note on shop drawings any changes from items specified listing reasons and giving source of change such as "Approved Equal", "Addendum", or "Change Order". The CONTRACTOR shall be responsible for conformance with drawings and specifications; for dimensions to be confirmed and correlated at the job site: for information that pertains solely to the fabrication processes or the techniques for construction; and coordination of the work with other trades. Receipt or approval of shop drawings by the ENGINEER does not relieve the CONTRACTOR of the responsibility of complying with Contract Documents.
2. All shop drawings (drawings and manufacturer's data) required under each section of this Division 26 shall be submitted at the same time and be bound together in one hard back, three ring binders per copy, properly indexed for the formal submittal. Binder shall be sized to adequately contain all the materials therein and shall be labeled as to the identity of the job and the sub-contractor.
3. Shop drawings shall include functional and descriptive literature of the particular item furnished complete with dimensional drawings, wiring or schematic diagrams, rough-in and installation instructions, knock-out locations, hangers or mounting devices, etc., as required for the proper checking and installation of the equipment. Catalog sheets without any reference made to the particular item will not be acceptable. All special features called for in Contract Documents shall be noted. Where performance test results of a product design are called for in the technical sections of these specifications, test data sheets shall be provided with the shop drawing submittal.

B. Material Lists: Include manufacturer, type and model number of equipment that will be provided as called for under each section of this Division 26.

C. Other Information: As required by the ENGINEER.

1.5 CODES, LICENSES AND STANDARDS

A. Perform work in accordance with best present-day installation and manufacturing practices. Comply with all applicable laws, building and construction codes, and requirements of governmental agencies under whose jurisdiction work is being performed. Unless specifically noted to contrary, conform with and test in accordance with applicable sections of latest revisions of the following codes and standards.

1. American Society for Testing and Materials (ASTM)
2. National Fire Protection Association (NFPA)
3. National Electrical Code (NFPA 70-NEC)
4. Insulated Power Cable Engineers Association (ICEA)
5. Underwriters Laboratories Inc. (UL)
6. American Steel and Iron Institute, "Design Manual on Steel Electrical Raceways"
7. National Electrical Manufacturer's Association (NEMA)
8. National Electrical Contractor’s Association (NECA)
9. American National Standards Institute (ANSI)
10. International Building Code (IBC)
11. State of Utah Electrical, Energy, Building and Safety Codes
12. Institute of Electrical and Electronic Engineers (IEEE)
13. Instrument Society of America

B. Conflicts Between Above Codes and Standards: The code or standard establishing the more stringent requirements shall be followed.

C. Conflicts Between Codes and Standards and Specifications and/or Drawings: The one establishing the more stringent requirements shall be followed.

1.6 MATERIALS AND WORKMANSHIP

A. Each type of equipment or material shall be the same make and quality. All materials and equipment shall be installed in accordance with the recommendations of the manufacturer as approved by the ENGINEER to conform to the Contract Documents.

B. The installation shall be accomplished by workmen skilled in the type of work involved.

C. All materials and equipment furnished and installed shall be of best quality, new, free from defects and meet the standards of NEMA, ICEA, UL, NFPA, IBC, OSHA, NEC, and shall bear their label wherever standards have been established and label service is available. Where materials and equipment are specified by manufacturer's name, the type and quality required is thereby denoted. The ENGINEER shall be afforded every facility, deemed necessary to observe and examine the materials and apparatus being installed to prove their quality.

D. Workmanship shall be the best quality of its kind for the respective industry crafts and practices, be neat and orderly throughout the project and shall be acceptable in every respect to the ENGINEER. Nothing contained herein shall relieve the CONTRACTOR from making good and perfect work in all details of construction.

E. The CONTRACTOR shall work in harmony with the ENGINEER and with other contractor's, companies or individuals working in connection with this project. Imperfections or discrepancies by other contractors shall not relieve responsibility of this CONTRACTOR. Store materials orderly and clean up without interference with other trades.

1.7 DEFECTIVE EQUIPMENT

A. If equipment fails to conform to detailed specifications or to operate satisfactorily, the OWNER will have the right to operate equipment until defects are corrected.
   1. The OWNER will have the right to operate rejected equipment until it is replaced, without cost for depreciation use or wear.
   2. Remove equipment from operation for examination, adjustment, alteration or change only at times approved by the OWNER.

1.8 STORAGE AND PROTECTION OF MATERIALS

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work under way, and apparatus against loss or damage.
B. Materials and apparatus shall be stored with environmental protection and other necessary conditions as recommend or required by the manufacturers.

1.9 RECORD DRAWINGS

A. The Contract Document drawings will be used by the CONTRACTOR who shall accurately and neatly mark in colored pencil all changes or deviations from the drawings as they are made in the work.

B. Refer to Section 01 70 00 Closeout Procedures and Record Drawings for additional requirements.

1.10 COORDINATION OF CONSTRUCTION

A. Coordinate work with other contractors, the OWNER, and the ENGINEER to assure orderly and expeditious progress of work. Select order of work and establish schedule of working hours for construction. This is subject to review by the OWNER if the work involved is part of a functioning facility. If such is the case, the CONTRACTOR shall carefully coordinate any disruption of service with the OWNER. Any after hours/weekend outages shall be accommodated at no additional cost to the OWNER.

B. The electrical work shall be laid out in advance of construction to eliminate unnecessary cutting, drilling, or channeling, etc. Where such cutting and drilling, or channeling becomes necessary for proper installation; perform with care, use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the OWNER. Cutting work of other trades shall be done only with the consent of the CONTRACTOR. Cutting of structural members shall be done only with the written approval of the ENGINEER.

C. Comply with the following:
   1. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
   2. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
   3. Install systems, materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

D. Cooperate with other trades to coordinate locations of electrical devices and apparatus.

E. Perform for other trades the electrical wiring and connections, for all devices or apparatus where not specified herein or indicated on the drawings. Consult the architectural and mechanical drawings to avoid the location of switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc. Hidden electrical devices and/or connections shall be relocated as directed, at no additional cost to the OWNER.

F. Where conduit, outlets or apparatus is to be cast in concrete or encased, it must be located and secured by a journeyman or foreman present at the point of installation. He shall check the locations of the electrical items before and after the concrete and masonry installation and shall relocate displaced items at no additional cost.

1.11 USE OF SUBSTITUTES

A. Equipment and materials are designated by one or more manufacturer's name brands or numbers. It is not the intent of the specifications to exclude other equipment or materials that equal or exceed the standard of those specified. If the CONTRACTOR desires to use substitute equipment or materials, he must submit for written approval as outlined in the General Conditions of the Contract Documents.

1.12 SITE CONDITIONS

A. Examination Of Site: Examination of the site shall be made by the CONTRACTOR, who shall compare it with the drawings and specifications and satisfy himself as to the conditions under which the work is to be performed. He shall, at such time, ascertain and check all conditions which may affect his work. No allowance shall subsequently be made in his behalf for any extra expenses to which he may be put due to failure or neglect on his part to make such examination.

B. Review of Plans: Review all work indicated on drawings and specified herein with proper authorities responsible for interpreting applicable codes, ENGINEER, and local inspector prior to commencement with construction as listed herein, but not necessarily limited thereto:

1. Visit site prior to executing bid.
2. Verify measurements and locations of field measurements of existing conditions and those developed by construction.
3. Confirm requirements of work at off-site, publicly owned property with local authorities
4. Confirm connection requirements, sizes and layout with local public utilities.
5. Conditions discovered in conflict with intent of drawings and/or specifications must be clarified with ENGINEER prior to execution of work.

1.13 CLEAN-UP

A. As the work progresses and on a daily basis, the CONTRACTOR shall remove from the premises and surrounding streets, alleys, etc., all rubbish and debris resulting from his operations and shall leave all equipment and material furnished by him absolutely clean and ready for use.

1.14 SUPERVISION:

A. A competent foreman or superintendent initially approved by the ENGINEER shall be at the site at all times to receive instructions and shall be empowered to act. He shall verify dimensions given on the drawings and report any discrepancies or inconsistencies to the ENGINEER before commencing the work. The ENGINEER, or his representative, will interpret the meaning of the drawings and specifications where questions arise.

1.15 SAFETY REGULATIONS

A. The CONTRACTOR shall comply with OSHA and all other safety codes required by law and shall furnish and place proper protection for prevention of accidents. He/she shall provide and maintain any necessary construction required to secure safety of life or property during the performance of his/her work, including the maintenance of sufficient lights to secure such protection.

1.16 DISPOSITION OF EXISTING EQUIPMENT REMOVED FROM SERVICE

A. Existing equipment and materials such as cables, switches, conductors, etc., which are removed and not reused in the new installation shall remain the property of the OWNER. The CONTRACTOR shall deliver such equipment to storage place as directed. Items not wanted by the OWNER shall be removed from the site and disposed of by the CONTRACTOR.

1.17 PERMITS AND FEES

A. Obtain all permits and pay all fees for inspections, required by code for all the work covered under Division 26 of the specifications. All fees shall be included in the contract price. The CONTRACTOR shall furnish a certificate of approval to the ENGINEER from each inspection authority at completion of the work.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 FIELD DESIGN CHANGES

A. No field changes, additions, or change in locations shall be made without written approval from the ENGINEER.

3.2 EXCAVATION AND BACKFILLING

A. The CONTRACTOR shall perform all excavation, trenching and backfilling work, and remove all debris in connection with his work. Backfilling shall be done with materials acceptable to the ENGINEER and thoroughly tamped in place. All disturbed surfaces shall be restored to their original condition and properly installed to eliminate any settlement. Inside and outside, backfill shall be in 6-inch layers, compacted to 95% of the "standard proctor test".

B. Perform excavation in a manner to protect walls, footings and other structural members, from being disturbed or damaged in any way.

3.3 ROUGH-IN REQUIREMENTS

A. Architectural, structural and mechanical drawings shall be continually consulted and referred to. Exact placement of sleeves, conduit, and equipment shall be provided for by checking building and equipment dimensions. Equipment requirements and dimensions related there to shall be determined from detailed rough-in dimensions of each piece of equipment shown on Shop Drawings furnished by manufacturer.

3.4 CUTTING AND PATCHING CHASES AND OPENINGS

A. Provide for all required cutting and patching, anchors, openings, slots, chases, etc., in construction for electrical work. Cutting and patching shall be performed under direction of CONTRACTOR and will leave no discernable scars.

B. The CONTRACTOR shall be responsible for block-outs or demolition work pertaining to the installation of the electrical system.

C. In Remodeling and/or Addition projects, all salvageable electrical equipment and materials that cannot be integrated into the new electrical network becomes the property of the OWNER. Remove from the premises materials which the OWNER decides not to keep, as directed by the ENGINEER.

3.5 WORKMANSHIP

A. The CONTRACTOR shall be held solely responsible for the proper installation of his work. He shall arrange with the proper contractors for the building in of anchors, etc., and for the leaving of required chases, openings, etc., and shall do all cutting and patching made necessary by his failure or neglect to make such arrangements with others. Any cutting or patching done by this CONTRACTOR shall be subject to the directions of the ENGINEER and shall not be started until approval has been obtained.

B. All cutting, welding or drilling of concrete or structural members shall be properly reinforced and patched to match as nearly as possible the surrounding work. Before cutting, welding or drilling any concrete or structural member, the CONTRACTOR shall secure the approval of the ENGINEER.

C. This CONTRACTOR shall assign persons in direct charge of work who are thoroughly experienced in the class of construction work specified herein. All labor shall be performed in a workman like manner by skilled workmen under the supervision of competent foremen.

D. This CONTRACTOR shall periodically remove all debris and waste in order to maintain safe working and operating conditions, and shall dispose of the same in an approved manner. At the completion of work, he shall remove all his rubbish, tools, scaffolds and surplus materials from and about the site, leaving his work clean and the areas ready for occupancy.

3.6 SEISMIC RESTRAINT

A. The International Building Code requires that not only the structure, but also major mechanical and electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the IBC, and SMACNA "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment so that the final design can be properly reviewed.

3.7 TESTS

A. On completion of the work, the installation shall be tested free from all grounds and short circuits.

B. Normal feeders, circuits, and service entrance conductors with wire size #2 and larger shall be tested for leakage phase-to-ground and phase-to-phase prior to energizing the electrical system. The CONTRACTOR shall submit a written report to the ENGINEER showing methods and readings taken. Voltage applied for testing shall not exceed two times normal operating voltage.

C. Submit a record of voltage readings and amp meter readings on all feeders, motor full load amps, outside lighting, and service conductors to the facility. If there are any abnormal conditions, they shall be brought to the attention of the ENGINEER in writing as a part of this submittal.

D. Refer to Section 26 05 08 Electrical Acceptance Tests for additional requirements.

3.8 SUBSTANTIAL AND FINAL COMPLETION

A. Notify the ENGINEER when work is considered to be complete, in operating condition, and ready for Substantial Completion.

B. The ENGINEER, after determining that installation is ready for Substantial Completion, will make walkthrough and perform operational tests deemed necessary to determine that provisions of specifications are satisfied and prepare a list of outstanding items.

C. The OWNER will not accept work nor make final payment to CONTRACTOR until ENGINEER has certified that work of CONTRACTOR is complete and in conformance with specifications and guarantees.

D. Leave the job in complete order ready for use. All fixtures and equipment shall be tight, fully equipped and completely cleaned. All equipment shall have been operated, checked and approved by the OWNER before the project can be accepted.

E. At the time of the substantial and final walkthroughs, the project foreman shall accompany the party and remove cover plates, panel and enclosure covers, and other access panels for the ENGINEER, to allow complete observation of the entire electrical system(s).

F. Notify the ENGINEER when work is considered to be complete, including list of outstanding items, and is ready for Final Completion. Refer to Closeout Procedures and Record Documents for additional requirements.

3.9 TRAINING

A. Instruct OWNER's operating personnel in proper operation of the complete electrical system including all electrical equipment, switching, disconnects, panels, controls, etc., during a scheduled training tour for the OWNER’s personnel of entire project after Substantial Completion and prior to Final Completion. Confirm complete understanding on part of OWNER's operating personnel. Utilize the Operations and Maintenance Manuals specified elsewhere during the instruction process.

3.10 GUARANTEE/WARRANTY

A. The following guarantee is a part of the specification and shall be binding on the part of the CONTRACTOR and shall be submitted by letter to the OWNER prior to acceptance.

B. The CONTRACTOR guarantees that this installation complies with the drawings and specifications in all respects, and is free from defects. He agrees to replace or repair, to the satisfaction of the ENGINEER, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after Final Completion.
C. The CONTRACTOR guarantees that the installation of OWNER furnished equipment is free from defects. He agrees to provide labor to repair or replace to the satisfaction of the ENGINEER any part of his installation of the OWNER furnished equipment (the respective equipment vendor will provide all parts and labor for the equipment), which may fail or be determined to be unacceptable within a period of one (1) year after Final Completion.

D. Electrical and instrumentation systems and equipment shall not be considered acceptable for Substantial Completion until they have performed in service continuously without malfunction for at least ten (10) days.

END OF SECTION

SECTION 26 05 05 – OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-26 Electrical General Requirements sections apply to work of this section.

1.2 SUMMARY

A. Furnish two sets of bound operation and maintenance manuals. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to maintain and repair the equipment. Copies of approved submittals shall be included for all equipment. Provide electronic copy of O&M manual.

1.3 OPERATION AND MAINTENANCE MANUAL FOR ELECTRICAL AND INSTRUMENTATION SYSTEMS

A. General:
   1. The "Operating and Maintenance Manual" (Electrical and Instrumentation) is a bound compilation of drawings and data that the owner requires for each building or project. These manuals, complete with drawings and data, shall be furnished to the Owner.
   2. The electrical CONTRACTOR has overall responsibility to obtain the necessary data and compile the data as set forth in this specification, including items or equipment purchased by the Owner and delivered to the CONTRACTOR for installation.
   3. The number of binders (or "volumes") required will depend on the amount of information to be catalogued. Total "sets" see paragraph 1.2A.
   4. Make all information legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of mechanical and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART 2 - PRODUCTS

2.1 PAGE SIZE:

A. All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 11 x 17 inches) folded to 8-1/2 x 11 inch.

2.2 DRAWINGS:

A. All drawings larger than 8-1/2" x 11" shall be folded and inserted in individual 8-1/2" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.3 BINDERS:

A. Binders shall be Buckram (stiffened fabric), bar-lock type binders with block lettering for sheet size 8-1/2 x 11 inches with 2" to 3-1/2" expandable metal capacity as required for the project. The number of binders, however, shall be based on not filling them beyond 4".

B. Place the following information on the front cover and backbone:
1. "Operation and Maintenance Manual".
2. Project Name and Number (and volume number if more than one volume).
3. Equipment name and number.
4. ENGINEER's name.
5. General CONTRACTOR's name.
6. Electrical CONTRACTOR's name.
(Items 4 through 6 need not be printed on the backbone.)

2.4 CONTENTS AND INDEXING

A. Manuals shall contain descriptions of the electrical, control, and instrumentation systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:
1. Copy of purchase order change (if any).
2. Outline drawings, special construction details, “as-built” electrical wiring and control diagrams with wire and terminal number for panel and field wiring for all major and supplementary systems.
3. Manufacturer’s test or calculated performance data and certified test curves.
4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.
5. Manufacturer’s brochure marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included.
6. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.
7. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:

Part I	Building and System Descriptions
Part II	Purchased Equipment Data
Part III	Test Reports and Charts
Part IV	Start-Up and Operation
Part V	Preventive Maintenance Recommendations

Part VI Software/Programming Data/Program CD's

8. A copy of the approved submittals for each piece of equipment.
9. A copy of all testing reports.
10. Wiring diagrams, marked with model and size and plan symbol.
11. The index shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.
12. Copies of developed software, programmed setpoints, screens, etc. on C.D.

END OF SECTION

SECTION 26 05 09 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Nameplates.
2. Labels.
3. Wire and cable markers.
4. Conduit markers.

1.2 APPLICABLE SECTIONS:

A. Section 26 05 00 - Electrical General Requirements.

1.3 SUBMITTALS:

A. Submit product literature including manufacturer name, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

PART 2 - PRODUCTS

2.1 NAMEPLATES:

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background, or to match nearby nameplates.

B. Locations:

1. Each electrical distribution and control equipment enclosure.
2. Communication cabinets.
3. Each junction box.

C. Letter Size:

1. 1/8" letters for identifying individual equipment and loads.
2. 1/4" letters for identifying grouped equipment and loads.

D. Identify control device stations, motor control equipment, process equipment and instrumentation equipment. All such devices shall be labeled with equipment served, identifying name, and circuit number with panel.

2.2 WIRE MARKERS:

A. Manufacturers:
   1. 3M
   2. Thomas & Betts
   3. Panduit

B. Description: Heat shrink tubing, imprinted, type wire markers.

C. Locations: Each conductor at panel-board gutters, pull boxes, outlet and junction boxes, and each load connection, PLC panels, instrument panels, instruments, MCC's, etc.

D. Legend:
   1. Power and Lighting Circuits: Branch circuit or feeder number shall be indicated on project Record Drawings.

E. Control Circuits: Control wire number shall be indicated on schematic and interconnection diagrams.

F. Data Wiring: Address number shall be indicated on each end of conductor on the face of the outlet cover, and on the space of the patch panel.

G. All conductor numbers and terminal block numbers shall be reflected on the CONTRACTOR submitted Record Drawings.

2.3 CONDUIT MARKERS:

A. Manufacturers:
   1. Tech Products
   2. Thomas & Betts
   3. Panduit

B. Description: 3/16" poly tag in poly tag holder. Tie wrapped to conduit.

C. Location: Furnish markers for each conduit longer than 6 feet.

D. Spacing: Label at each junction and terminal end.

E. Legend: Number as indicated in contractor prepared Record Drawings.

2.4 UNDERGROUND WARNING TAPE:

A. Description: 4" wide detectable plastic tape, colored red with suitable warning legend describing buried electrical lines.

B. Location: Along length of each underground conduit, 12" above conduit.

2.5 LABELS:

A. Self adhesive, plastic coated, machine printed.

B. Manufacturer: Brother or equal.

C. Locations:

1. Convenience outlet circuit adhered to outlet faceplate showing panel and circuit number.
2. Data address number to outlet faceplate and patch panel face plate.
3. Light switches, indicating lighting switched panel and circuit number.
4. Process wiring indicating connection point terminal block and cabinet.

PART 3 - EXECUTION

3.1 PREPARATION:

A. De-grease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION:

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws.

C. Secure nameplate to inside surface of door on panel-board that is recessed in finished locations.

D. Identify each conduit at each end.

E. Identify underground conduits using one underground warning tape per trench at 12" above conduit.

END OF SECTION

SECTION 26 05 19 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conductors and cables as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 APPLICABLE SECTIONS

A. Section 26 05 00: Electrical General Requirements.

B. Section 26 05 08: Electrical Acceptance Tests

PART 2 - PRODUCTS

2.1 COMPONENTS

A. 600 Voltage Conductors:

1. Copper with AWG sizes as shown or required:

a. Minimum size shall be No. 12 except where specified otherwise.

b. Conductors shall be stranded.

1) Insulation:

a) Conductor Size No. 2 And Smaller: 600V type THHN or XHHW (75° C). All conductors run in underground conduits shall be XHHW.

b) Conductor Size No. 1 And Larger: 600V Type THHN or XHHW-2 (90° C).

2) Colors:

a) 120/240 V System

(1) Black: Line 1.

(2) Red: Line 2.

(3) Green: Ground.

(4) White: Neutral.

b) 208Y / 120 V System:

(1) Black: Phase A.

(2) Red: Phase B.

(3) Blue: Phase C.

(4) Green: Ground.

(5) White: Neutral.

c) 480Y / 277 Volt System:

(1) Brown: Phase A.

(2) Orange: Phase B.

(3) Yellow: Phase C.

(4) Neutral: Gray.

(5) Ground: Green.

d) Conductors size No. 10 and smaller shall be colored full length. Tagging or other methods for coding of conductors size No. 10 and smaller not allowed.

e) For feeder conductors larger than No. 10 at pull boxes, gutters, and panels, use taped band or color tag color-coded as specified above.

B. Instrumentation Cables:

1. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 16 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.

2. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

3. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

4. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

C. Control Wires:

1. Copper with AWG sizes as shown or required:
   a. Minimum size shall be No. 14 except where specified otherwise.
   b. Conductors shall be stranded.
      1) Insulation:
         a) 600V type XHHW (75° C). All conductors run in underground conduits shall be XHHW.
2. Control wires may be run in same conduits as instrumentation cables.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Conductors and cables shall be continuous from source to equipment.
2. Do not use direct burial cable.
3. Instrumentation and control wires shall be run in conduits separate from power conduits.

B. 600 Voltage Conductors:

1. Install conductors in raceway except where specifically indicated otherwise. Run conductors of different voltage systems in separate conduits. All raceways shall include an equipment ground conductor.
2. Route circuits at own discretion, however, circuiting shall be as indicated or required. Group circuit homeruns to panels as shown on Drawings. No other groupings of circuits will be allowed.
3. Neutrals:
   a. On three-phase, 4-wire systems: Do not use common neutral for more than one three phase circuit.
   b. On single-phase, 3-wire systems: Do not use common neutral for more than one circuit per phase.
   c. Run separate neutrals for each circuit where specifically noted on Drawings.
   d. Where common neutral is run for two or three home run circuits, connect phase conductors to breakers in panel which are attached to separate phase legs so neutral conductors will carry only unbalanced current. Neutral shall be sized at 200% of full load.
4. Pulling Conductors:

a. Do not pull conductors into conduit until raceway system is complete and enclosures, cabinets, and boxes are free of foreign matter and moisture.

b. Install conductors in accordance with the manufacturer's requirements.

c. Use only listed non-hardening wire pulling lubricants.

5. Provide positive supports for conductors in vertical raceways at following spacing minimum, unless shorter is recommended by manufacturer.

a.	No. 18 to 1/0	100 feet.
b.	No. 2/0 to 4/0	80 feet.
c.	250MCM to 350MCM	60 feet.
d.	350MCM to 500MCM	50 feet.

C. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

D. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

E. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. CONTRACTOR shall supply terminal boards as required.

2. Do not field wire directly to devices.

F. Low Voltage Cables In Office Spaces (70 Volts or Less):

1. Run cables in raceway.

END OF SECTION

SECTION 26 05 22 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install wiring devices as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device -Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

E. UL - Underwriters Laboratories, Inc.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
1. Hubbell, Model HBL-1221, 1223, 1224 series.
2. Arrow Hart, Model 1991.

B. Description: NEMA WD 1, Heavy-Duty Specification Grade AC only general-use snap switch.

C. Body and Handle: White plastic with toggle handle.

D. Indicator Light: Lighted handle type switch red color handle.

E. Locator Light: Lighted handle type switch; red color handle.

F. Ratings:
1. Voltage: 120-277 volts, AC.
2. Current: 20 amperes.

2.2 RECEPTACLES

A. Manufacturers:
1. Hubbell, Model HBL 5362-W.
2. Arrow Hart, Model 5362-W.

B. Description: NEMA WD 1, Heavy-duty specification grade general use receptacle.

C. Device Body: White plastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

A. Decorative Cover Plate: Brushed stainless steel in electrical/control/blower rooms.

B. Process Room/Exterior Cover Plate: Gasketed cast metal with hinged gasketed device cover. Lever type switch cover. Classified hazardous as required for process areas per drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that outlet or device boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on bottom.

E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by back wire only. Stranded conductors shall not be wrapped around screws.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install wall switch 48 inches above finished floor.

B. Install convenience receptacle 18 inches above finished floor unless otherwise indicated.

C. Install convenience receptacle 6 inches above back-splash of counter.

D. Install dimmer 48 inches above finished floor.

E. Install telephone jack 18 inches above finished floor.

F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.

G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

F. Verify that each telephone jack is properly connected and circuit is operational.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 05 24 - EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. This section includes wiring connections to equipment specified in other sections.

B. Electrical connections to equipment: Provide the materials and make the electrical connections to all equipment having electrical requirements as indicated in the architectural and/or mechanical section of the specifications and drawings.

C. Provide conduit, wiring, connect motors and other mechanical equipment and electrical devices in other sections; also install, provide, support for, and connect starters, other control devices, control panels, furnished for such motors and equipment. Leave in satisfactory operating conditions.

D. Provide control devices for equipment in addition to those furnished by the trades providing such equipment; refer to schedules on electrical and mechanical drawings for control devices to be furnished under scope of the electrical work.

E. Control devices and panels furnished by trades providing equipment will be delivered to electrician at site of project; acknowledge acceptance in writing; assume responsibility for particular installation before proceeding with installing and wiring them. Follow each manufacturer's printed installation directions and wiring diagrams for installing and making connections to his equipment and controls.

F. Consult contract drawings and specifications of trades providing equipment and controls, for control wiring diagrams, also refer to their shop drawings in order to become familiar with equipment type and operation of controls, their locations and extent of work required for installing, wiring and connecting them.

G. Starters for all motors requiring same shall be furnished by electrical contractor.

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary Conditions, Special Conditions, alternates, and addenda, applicable drawings, and the specifications including but not limited to the following:

A. Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

A. Section 01 50 00 - Quality Control:

B. NEMA WD 1 - General Purpose Wiring Devices.

C. NEMA WD 6 - Wiring Devices - Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Section 01 30 00 – Submittals: General.

B. Section 26 05 00 - Submittals: Procedures for submittals.

C. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.6 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Manufacturers:
1. Hubbell.
2. Or equal.

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

D. Cord Construction: NFPA 70, Type SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit over-current protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energizing

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in all locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Grounding electrodes and conductors.
2. Equipment grounding conductors.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

A. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

B. NFPA 70 - National Electrical Code.

1.4 GROUNDING SYSTEM DESCRIPTION

A. Metal underground water pipe.

B. Metal frame of the building.

C. Concrete-encased electrode.

D. Rod electrode.

E. Plate electrode.

F. Active electrode.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 25 ohms maximum.

1.6 SUBMITTALS FOR REVIEW

A. Section 01 30 00 – Submittals: General.

B. Section 26 05 00 - Submittals: Procedures for submittals.

C. Product Data: Provide for grounding and bonding equipment.

D. All submittals shall include a list of all items being submitted by description, manufacturer and catalog number.

1.7 SUBMITTALS FOR CLOSEOUT

A. Section 26 05 05 - Operation and Maintenance Manuals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

C. Certificate of Compliance: Indicate approval of installation by the authority having jurisdiction.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Material: Copper Clad Steel.

B. Diameter: 5/8 inch.

C. Length: 10 feet (3000 mm).

2.2 CONNECTORS

A. Manufacturers:
1. T&B
2. Burndy - Hi-Ground
3. ERICO® - Cadweld®

B. Material: Irreversible Crimp Style or Exothermic Weld.

2.3 WIRE

A. Material: Stranded copper, tinned.

B. Grounding Electrode Conductor: Size as indicated in the Drawings, or if modified or not indicated, size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install electrodes at locations indicated and in accordance with manufacturer's instructions. Install additional rod electrodes as required to achieve specified resistance to ground.

B. Provide grounding electrode conductor (UFER) and connect to reinforcing steel in foundation footing. Bond steel together.

C. Provide bonding to meet Regulatory Requirements.

3.3 FIELD QUALITY CONTROL

A. Perform inspections and tests listed in NFPA ATS, Section 7.13.

END OF SECTION

SECTION 26 05 30 - CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conduits and raceway systems as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

C. Proposed location and details of construction for openings in slabs and walls for conduit runs.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 PROJECT/SITE CONDITIONS

A. GENERAL:

1. Unless otherwise specified, equipment and materials shall be sized and derated for ambient site conditions, but in no case less than an ambient temperature of 40 degrees C at an elevation ranging from seal level to 4,300 feet without exceeding the manufacturer’s stated tolerances.

B. AREA CLASSIFICATIONS

1. See drawings for conduit types to use in each building area.

2. For the purpose of delineating the basic electrical construction materials and installation requirements for this project, areas of the project have been classified on the contract drawings as defined below. Electrical work within these areas shall conform to the requirements described below as well as the referenced code requirements.

a. General Purpose (NEMA 1): Areas requiring general purpose (NEMA 1) construction are indoor areas typically architecturally finished, always dry, and occupied by plant personnel.

b. Corrosive Process Areas (NEMA 4X): Areas requiring corrosion resistant (NEMA 4X) construction. Corrosive process areas typically contain pumping or piping systems and are subject to spills and washdown. Corrosive process areas shall also include those areas containing corrosive chemicals.

c. Outdoor Areas (NEMA 3R): Areas outdoors require weather resistant (NEMA 3R) rating.

d. Hazardous Areas (NEMA 7): Unless otherwise indicated on the contract drawings, areas requiring hazardous location (NEMA 7) construction are classified as Class 1, Division 2 or Class1, Division 1 hazardous locations per Articles 500 and 501 of the National Electrical Code. See classification drawings.

e. Process Areas (NEMA 12): Areas requiring drip-proof (NEMA 12) construction are indoor process and support system areas and are not typically subject to spills, direct washdown, or corrosive chemicals under normal operating conditions, but may experience occasional or unintended wetness.

C. CONSTRUCTION MATERIALS:

1. Construction materials required for each area classification are listed in table A below. Refer to the individual specification section for each component for material composition and installation practices.

	Area Classification				
Component	NEMA 1	NEMA 3R[1] Outdoor	NEMA 4X[1] Indoor Corrosive	NEMA 12[1]	NEMA 7 Classified Explosion Proof/Process Area
Conduit (exposed)	GRS	RA PGRS	RA PGRS	RA PGRS	PGRS
Conduit (concealed)[4]	EMT[3]	PGRS GRS	RA	GRS	GRS
Flexible conduit[5]	LFS	LFS	LFN	LFN	Classified
Support systems	Galvanized Steel	Aluminum	Stainless steel	Aluminum	Stainless steel

Fastening hardware and hanger rods	Cadmium plated steel	Stainless steel	Stainless steel	Cadmium plated steel	Stainless steel
Control Stations[2,6]	Painted Steel	Non-Metallic	Non-Metallic	Painted Steel	Classified
Enclosures[2,6]	Painted Steel	Non-Metallic	Non-Metallic	Painted Steel	Classified
Receptacles[2] Surface Recessed	General General	WP[8] WP[8]	WP[8] N/A	WP[8] WP[8]	Classified N/A
Switches[2] Surface Recessed	General General	WP[8] WP[8]	WP[8] N/A	WP[8] WP[8]	Classified N/A

Notes:

1. Enclosures, device boxes, control stations and raceway systems shall be mounted with ¼-inch (minimum) space between the electrical system and supporting structure.
2. Conduit terminations to control stations, enclosures, and device boxes in NEMA 3R, 4X, 7 and 12 areas shall be made through threaded hubs.
3. Rigid conduit concealed in framed walls, block walls and ceiling spaces shall be electrical metallic tubing, type EMT.
4. Conduit ductbank or beneath slab on grade shall be rigid PVC-40 conduit, without pullboxes, and with waterproof conduit splices beneath grade to limit water penetration.
5. Flexible conduit shall be utilized for final connections to equipment.
6. Control station and enclosure sealing ratings shall meet or exceed the rating designated by the area classification.
7. Exposed conduit systems in areas containing equipment handling Ferric Chloride shall be PGRS.
8. Use gasketed lever type switches and up-in use red dot steel receptacle covers.

Legend:

EMT	Electrical Metallic Tubing
GRS	Galvanized Rigid Steel
LFS	Liquid Tight Flexible Steel
LFN	Liquid Tight Flexible Non-Metallic
PGRS	PVC Coated Galvanized Rigid Steel

PVC4	PVC Schedule 40
PVC8	PVC Schedule 80
RA	Rigid Aluminum
WP	Weatherproof – Use cast device boxes with threaded hubs
XP	Explosion proof – Approved conduit systems per classification listing
N/A	Non applicable

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING

A. GENERAL: Provide conduit and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 1/2".

B. ELECTRICAL METALLIC TUBING (EMT):

1. Per UL "Standard for Electrical Metallic Tubing" No. 797. Galvanized mild steel with interior coat of enamel.
2. Fitting shall be steel, compression type. Cast type or indenter type fittings are not acceptable.
3. Approved for Operations Building attic.

C. GALVANIZED RIGID METAL CONDUIT (GRC): FS WW-C-0581 and ANSI C80.1.

1. Per USAS C80.1, zinc-coated by hot-dip galvanizing.
2. Couplings shall be threaded type of same material and finish as conduit. Connectors shall be Myers hubs or equal of same material and finish as conduit.
3. Approved Locations: Interior where exposed, where not exposed to moisture or corrosive atmosphere.

D. POLY VINYL CHLORIDE PLASTIC PIPE (PVC), SCHEDULE 40, Based on Outside Diameter:

1. PVC heavy wall (PVC-40) suitable for direct burial. 1” minimum size.
2. Fittings shall be of same material as conduit. Water-tight splices required to limit water penetration. All elbows shall be PVC coated GRS
3. Approved for underground direct burial, May be used where buried in earth under floor slabs.
4. Minimum depth of bury under slab shall be 18 inches or of sufficient depth to allow for bending radius to rise out of the slab vertically. Shall have an exposed grounding electrode conductor in each trench.
5. Not approved for above grade installation nor for embedding in concrete slabs.

E. PVC COATED GALVANIZED RIGID METAL CONDUIT (PGRC): NEMA RN 1.

1. Rigid galvanized conduit, prior to plastic coating, shall conform to ANSI Standard C80.1, UL 6, and CSA Standard C22.2 #45.
2. Nominal thickness of exterior PVC coating shall be 40 mils. A two-part red urethane coating of 2 mil thickness shall be applied to the interior of all conduits and fittings.
3. All hollow conduit fittings which serve as part of the raceway system shall be coated with exterior PVC coating and red interior urethane coating as described above.
4. Coated conduit shall conform to NEMA Standard No. RN1-1989. Shall be "Plastic-Bond Red" as manufactured by Robroy Industries, Inc.
   a. Approved Locations: Shall be used in all locations where conduits are buried, in contact with earth, and in wet and corrosive areas, and as noted on the drawings. All buried conduit between VFDs and motors. All risers through concrete floors, all embedded conduit, and all elbows of ductbanks underground.
   b. Required in the chemical rooms.

F. LIQUIDTIGHT FLEXIBLE METAL CONDUIT: UL 360.

1. Galvanized steel with an extruded liquidtight PVC cover that is moisture and oil-proof, and UV resistant.
2. Fittings shall be liquidtight compression type, listed for grounding.
3. Approved for flexible connections to equipment subject to vibration such as motors, fan, pumps, dry transformers, etc., 36-inch maximum, 18" minimum length for each connection.

G. FLEXIBLE METAL CONDUIT: UL 1.

1. Galvanized steel.
2. Approved for flexible connections to equipment in attic of the Administration Building.

H. RIGID ALUMINUM CONDUIT:

Aluminum conduit NOT USED.

I. CONDUIT BODIES:

1. Form 7 malleable iron with hot dip galvanized finish, PVC coated in wet or process areas of plant.
2. Gasketed cast iron, zinc plated cover with stainless steel screws.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS

A. General Requirements: Wiring shall consist of insulated conductors installed in conduits or raceways.

3.2 CONDUIT AND TUBING SYSTEMS

A. Conduit and tubing systems shall be installed as indicated. Conduit sizes are based on the use of insulated, copper conductors. Minimum size of raceways shall be as noted. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. PVC coated rigid metal conduit will be used in damp, wet or corrosive locations and the conduit or tubing system will be provided with the appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Any exposed threads or metal shall be touched up with 3 coats of touch up material provided with conduit. Raceways shall be kept 6" away from parallel runs of any mechanical piping. Raceways shall be concealed where possible. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings and will provide continuity for grounding.

3.3 BELOW SLAB-ON-GRADE OR IN THE GROUND

A. All electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing through slabs-on-grade shall be PVC coated rigid metal conduit. PVC conduits shall be installed below slab-on-grade or in the earth. All underground bends over 22º and risers through concrete slab shall be PVC coated GRC.

3.4 INSTALLED IN SLABS INCLUDING SLABS ON GRADE

A. Conduit shall not be embedded in concrete slabs except as specifically detailed.

3.5 EXPOSED RACEWAYS

A. Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above ceilings shall be considered as exposed installations.

3.6 CHANGES IN DIRECTION OF RUNS

A. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field made bends and offsets shall be made with an approved hickey or conduit bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp or wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed from obstructions or shall be replaced.

3.7 SUPPORTS

A. Metallic conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10' and within 3' of boxes, cabinets, enclosures, and fittings, with U-channel support systems, one hole conduit straps with clamp backs, and conduit hangers. All supports mounted in exterior, process, or exposed areas subject to corrosive atmosphere shall be stainless steel. Supports in other areas shall be hot dipped galvanized. C-clamps or beam clamps shall have strap or rod type retainers. Rigid plastic conduits (if permitted as wiring method) shall be supported as indicated above, except that they shall be supported at 3'-0" maximum on centers and as indicated in the NEC (NFPA 70). Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging.

B. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a power charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or supports shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4" in concrete joints shall avoid cutting the main reinforcement bars. Holes not used shall be filled. In partitions of light steel construction, sheet metal screws shall be used. Conduits shall not be supported using wire or nylon ties.

C. Raceways shall be installed as a complete system and shall be independently supported from the structure. Upper raceways shall not be supported of lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts and shall not be fastened to hung ceiling supports.

D. Support Installations:

1. U-channel supports generally are not detailed but must be adequate to support combined weights of conduit and conductors.

2. Clamps: Galvanized malleable iron one-hole straps with clamp backs, beam clamps or other approved device with necessary bolts, expansion shields. Perforated metal straps shall not be used.

3. Adjustable U-channel Supports: Used to support horizontal runs only, use trapeze hangers for parallel runs of conducts.

4. Surface mounted raceway bases shall be anchored to ceiling members or block walls on 5'-0" centers maximum spacing and at all junction and device boxes and at angle fittings. Anchors shall be: Expansion shields on concrete or solid masonry, toggle bolts on hollow masonry units or on suspended ceilings.

3.8 INSTALLATION OF RACEWAYS AND FITTINGS:

A. General:

1. All Conduit: In accordance with requirement of National Electrical Code and applicable local codes.

2. Steel Conduit: In accordance with recommendations of American Iron and Steel Institute "Design Manual on Steel Electrical Raceways," latest edition.

B. Electrical Continuity:

1. All metallic conduit systems shall be electrically continuous throughout.

C. Moisture:

1. All conduit systems shall be essentially moisture tight.

D. Alignment of Exposed Conduit:

1. Parallel with or at right angles to lines of structure.

E. Field Cuts and Threads:

1. Cuts shall be square, threads clean and sharp. Remove sharp or rough edges by reaming burrs. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of rigid steel conduit. Apply coat of red lead, zinc chromate or special compound recommended by manufacturer of conduit where conduit protective coating is damaged.

F. Bends:

1. Uniform, whether job-fabricated or made with standard fittings or boxes. Do not dent or flatten conduit.
2. Exposed Conduit: Symmetrical insofar as practicable.

G. Location:

1. Routing: Generally shown in schematic fashion, unless dimensioned or noted to contrary. Contractor shall determine actual routing as approved.
2. Conduit Not Shown: Contractor shall route as required to connect equipment as specified.
3. Vertical Risers, Equipment and Device Locations: Approximately as shown. Contractor shall coordinate installation of conduit, in locations indicated, with structure and equipment.
4. Conduit in Relation to Steam or Hot Water Lines or Other Hot Surfaces: Locate minimum of 6" away. If such separation is impracticable, protect from heat as approved.

H. Buried Conduit:

1. Depth of Burial: Minimum of 24" below finished grade with warning tape 12" above conduit.

I. Wall Penetrations: Required for passage of conduits installed by CONTRACTOR through walls, or partitions.

1. Penetrations Through Exterior Building Walls: Cast in sleeve/Core drill wall and provided conduit entrance seals as detailed. All penetrations shall be with rigid steel conduit PVC coated within the plant process areas.
2. Openings Required Through Existing Partitions: Shall be provided at CONTRACTOR's expense. Holes through masonry construction shall be cast/ drilled with suitable coring machine. Perform work neatly. Patches shall match original material in composition and appearance.

3. Provide fire seals where a fire rated partition or wall is penetrated.

J. Expansion Fittings:

1. Install in all conduit runs crossing structural expansion joint or in straight runs 75 feet or more in length.

K. Conduit Ends:

1. Cap spare conduits.
2. Open Conduit Ends Terminating in Switchboards, Cabinets or Similar Locations Where Exposed to Entrance of Foreign Material: Install insulating grounding bushing. Plug space around cables with sealing compound.
3. Cap or plug conduit ends to prevent entrance of foreign material during construction.

L. Conduit Connections:

1. Cabinets, Enclosures, and Boxes: Double lock nuts and insulating bushings for rigid conduits in unclassified areas, NEMA 1. Hubs for rigid conduits in damp, wet, exterior, or corrosive areas, NEMA 12, 3R, 4, 4X. Bushings, insulating type, bell ends, or insulated throat fittings shall be installed on the ends of all conduits. Grounding type fittings and bushings shall be utilized as required for bonding.
2. Metallic Conduit Terminating in Non-Metallic Manholes or Pull Boxes: Insulated grounding bushing with lay-in ground lugs.
3. Flexible conduit for connection to movable equipment shall be liquidtight, utilizing listed liquidtight fittings.

M. Cleaning:

1. Clean and swab inside of conduits by mechanical means to remove foreign materials and moisture before conductors are installed.

N. Spare Conduits:

1. Install nylon pull line for future installation of cables. Cap all conduits and mark where end is located on Record Drawings with dimensions.

END OF SECTION

SECTION 26 05 34 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install electrical boxes and electrical fittings as required, and as shown on the Drawings. Materials employed shall be as indicated on the drawings and as specified herein.

B. Types of electrical boxes and fittings in this section include the following:
   1. Outlet boxes
   2. Junction boxes
   3. Pull boxes
   4. Conduit bodies
   5. Bushings
   6. Locknuts and hubs
   7. Knockout closures
   8. Miscellaneous boxes and fittings.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings.

B. Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxed, covers and box supports. Provide electrical boxes and fittings, which have been UL listed and labeled.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

A. Flush Interior Outlet or Device Boxes: Provide one piece, galvanized flat rolled sheet steel interior wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices; minimum depth 1-1/2". Provide minimum 2-1/8" depth for boxes with three or more conduit entries.

B. Interior Outlet or Device Box Accessories: Provide box accessories as required for each installation, including mounting brackets, hangers, extension or plaster rings, fixture studs, cable clamps and metal straps for supporting boxes, which are compatible with boxes being used and fulfilling requirements of individual wiring applications.

C. Exposed Outlet or Device Boxes: Provide corrosion- resistant cast-metal type FD weatherproof wiring boxes of types, shapes and sizes (including depth) required, with integral threaded conduit hubs, face plates with spring-hinged waterproof caps suitably configured for each application, with face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Provide junction and pull boxes with covers of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless hardware. Provide underground concrete junction boxes as required or indicated on the Drawings. Provide cast steel boxes with threaded hubs and gasketed cover as required or indicated on the Drawings.

E. Conduit Bodies: Provide galvanized cast-metal Form 7 conduit bodies of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

F. Bushings, Knockout Closures, Locknuts, and Hubs: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and hubs, and conduit bushings and offset connectors of types, and sizes to suit respective uses and installation.

G. All boxes, fittings, and conduit bodies shall be PVC coated wherever PVC coated conduits are required elsewhere in this specification.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. General: Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

C. Provide cover plates for all boxes. See Section 26 05 22, Wiring Devices.

D. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.

E. Provide knockout closures to cap unused knockout holes where blanks have been removed.

F. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Install recessed boxes with face of box or ring flush with adjacent surface.

G. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them.

H. Provide electrical connections for installed boxes.

END OF SECTION

SECTION 26 09 13 - CONTROL DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. This section sets forth the general specification and requirements for the control devices that shall be provided with control panels, motor starters, and other enclosures in order to assemble a complete and operable control, alarm, or indicating system.

B. The SUPPLIER shall coordinate the installation of items specified herein as required to ensure the complete and proper interfacing of all the components and systems.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.3 APPLICABLE REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1985; Incl. Rev. I and 2; ICS-6) Enclosures for Electrical Equipment

NEMA ICS 1 (1988) General Standards for Industrial Controls and Systems

UNDERWRITERS LABORATORIES, Inc. (UL)

UL 50 Enclosures for Electrical Equipment

UL 508 Industrial Control Equipment

1.4 SUBMITTALS

A. Provide complete submittal information for the control devices in accordance with Section 26 05 00.

B. Comply with the following requirements:

1. Submit certified dimensional drawings and manufacturer’s data sheets for each size and type of device specified herein to be utilized. Data sheets are to be highlighted to define the specific materials of construction and features specified herein along with detailed manufacturer’s model number.

2. Submit instruction bulletins for each type of control device. The instruction bulletins shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, calibration instructions, and any other details of a specialized nature to the devices furnished.

C. Additional submittal requirements:

1. Circuit Breakers and/or fuses:

a. Provide a complete schedule showing load and rating of circuit breakers and/or fuses.

2. Control power transformers and/or power supplies:

a. Provide complete sizing calculations in accordance with the requirements identified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturers have been indicated for various specified devices to establish the standard of quality and performance of the equipment to be supplied.

B. Devices of a given type shall be of the same model, class, or rating, have the same general appearance, and be from the same manufacturer.

2.2 GENERAL REQUIREMENTS

A. Analog measurements and control signals shall:

1. Be electrical as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted.

2. Electrical signals outside control panels shall be 4 to 20 mA DC, except as noted.

3. Signals within enclosures may be 1 to 5 VDC, or 0-10 VDC.

4. Dropping resistors shall be installed at all field side terminations in the control panels to ensure loop integrity.

B. Control panels provided with integral power supplies and control power transformers shall be configured to match the voltage and current requirements of the loads.

C. Each 120 VAC control loop or instrument shall have an individual circuit breaker or fuse within its respective control panel and clearly identified for function.

D. Each PLC output shall have its own individual fuse external of the I/O card, with blown fuse indication.

1. Size external fuse to open before any I/O card mounted fuses.

E. Signal isolators, Signal Converters, and Power Supplies:

1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required:

a. To ensure adjacent component impedance match.

b. Where feedback paths may be generated.

c. To maintain loop integrity when the removal of a component of a loop is required.

2. Signal converters shall be included where required to resolve any signal level or signal type incompatibilities.

3. Power supplies shall be included, as required by the device manufacturers' load characteristics, to ensure sufficient power to each loop component.

2.3 CONTROL DEVICES

A. Signal Isolators and Converters.

1. Signal isolators shall have complete isolation of input, output and power input.
    a. Signal input shall be 4-20 mA into 50 ohms, maximum.
    b. Signal output shall be 4-20 mA into 1000 ohms, minimum.
    c. Power input shall be 120 VAC, 60 Hz or 24 VDC.
    d. Span and zero shall be adjustable.
    e. Accuracy shall be ±1 percent of span.
    f. Units shall be surface or DIN rail mounted.
2. Signal Converters
    a. Signal inputs of 1-5 V, 0-10 V, etc.
    b. Signal output shall be 4-20 mA into 1000 ohms, minimum.
    c. Power input shall be 120 VAC, 60 Hz or 24 VDC.
    d. Span and zero shall be adjustable.
    e. Accuracy shall be ±1 percent of span.
    f. Units shall be surface or DIN rail mounted.
3. Acceptable manufacturers:
    a. Acromag.
    b. AGM Electronics Model TA-4000.
    c. Or approved equal.

B. Relays

1. General Purpose Relays:
    a. General purpose relays shall be plug-in type.
    b. Contacts rated 10 amperes at 120 Volts AC.
    c. With LED indication when engergized.
    d. Quantity and type of contacts shall be as shown on the Plans or as needed for system compatibility.
    e. Each relay shall be enclosed in a clear plastic heat and shock resistance dust cover.
    f. Sockets for relays shall have screw type terminals.
    g. Provide transient surge protection across the coil of each relay.
    h. Relays shall be:
        1) Potter and Brumfield Type KRP or KUP.
        2) IDEC.

3) Square D Type K.

4) Allen Bradley.

5) Or approved equal.

2. Slave and Interposing Relays:

a. Additional slave relays shall be provided when the number or type of contacts shown exceeds the contact capacity of the specified relays and timers.

b. Additional relays shall be provided when higher contact rating is required in order to interface with starter circuits or other equipment.

c. Shall be provided to compensate for voltage drop due to long wire runs.

d. The slave and interposing relays shall be as the general purpose relays.

e. Provide transient surge protection across the coil of each relay.

3. Time Delay Relays

a. Time delay relays shall be electronic on-delay or off-delay type.

b. Contacts shall be rated 10-amperes at 120 VAC.

c. Units shall include adjustable dial with graduated scale covering the time range in each case.

d. Provide transient surge protection across the coil of each relay.

C. Manual Operators and Interface Devices - Unclassified Areas

1. General Requirements

a. NEMA Type 13 Oil tight.

b. With synthetic rubber gasket.

c. Heavy duty.

d. Industrial grade full size 1 – 13/64” diameter.

2. Pushbutton Units:

a. Contacts rated:

1) NEMA A600.

2) 600 VAC maximum.

b. Color Code:

1) Red - Stop

2) Green - Start

3) Orange - Open

4) Blue - Close

c. As manufactured by:

1) Allen Bradley 800T.
2) Square D Type K.
3) Cutler-Hammer 10250T Series.

d. Furnish one spare normally open and normally closed contact with each switch.

3. Selector Switches:
   a. Contacts rated:
      1) NEMA A600.
      2) 600 VAC maximum.
   b. As manufactured by:
      1) Allen Bradley 800T.
      2) Square D Type K.
      3) Cutler-Hammer 10250T Series.
   c. Furnish one spare normally open and normally closed contact with each switch.
4. Pilot Lights:
   a. Transformer type LED pilot lights.
   b. 120 VAC or Low Voltage.
   c. Push to Test type.
   d. As manufactured by:
      1) Allen Bradley.
      2) Square D Type K.
      3) Cutler-Hammer 10250T Series.

E. Terminal Blocks
1. Din rail mounted.
2. Terminal to be of the tubular screw type with pressure plate to minimize the possibility of breaking wire strands during tightening.
3. Recessed terminal hardware to minimize the possibility of contact with current carrying parts.
4. Molded of high dielectric material.
5. Minimum rating 600 VAC, 30 amp.
6. External connections to and from all control panel must be via terminal blocks, including power, control, alarm, instrumentation, monitoring, and solenoid circuits.
7. Individual terminals and terminal blocks shall be marked in a permanent manner with printed identification.
8. As manufactured by:

a. ABB Entrelec M 4/6

b. Phoenix Contact UK 5 N

c. Or approved equal

F. Conductors within Control Panels

1. Single conductors shall be as follows:

a. Material: Soft annealed coated copper per ASTM B33 or B189.

b. Standard: ICEA S-19-81.

c. Stranded Wire - Class B.

d. Insulation and Coverings:

1) Thickness: Per ICEA.

2) Material:

a) No. 8 and Smaller: Type XHHW single conductor, copper power cable, moisture resistant, flame retardant thermoplastic insulation, 600 volt, 75 °C.

b) No. 6 and larger: Type XHHW-2 single conductor, copper power cable, heat and moisture resistant, flame retardant, thermoplastic insulation, 600 volt, 75°C.

e. No. 14 AWG minimum, shall be used for field control circuits, unless otherwise noted.

f. No. 16 AWG minimum, Type MTW shall be used for all PLC I/O connections within the panel; between I/O device and field wiring terminal blocks.

2. Instrumentation Cable (Shielded Twisted Pair STP):

a. Minimum conductor size 18 AWG.

b. Stranded and tinned copper conductors.

c. Polyethylene conductor insulated.

d. Foil aluminum-polyester shield – 100% shielding.

e. Minimum 18 AWG, stranded, tinned, copper drain wire.

f. PVC outer jacket.

g. UL Listed, TC rated.

h. 600 volt insulation level.

G. Wire markers:

1. Conductors within the control panel are to be permanently marked with wire numbers at each end.

2. Wire numbers are to correspond to the wire numbers indicated on the submittal drawings and are to correspond to the terminal block number to which they are attached in the control panel.

3. Markers shall be heat shrinkable tubing, imprinted type wire markers.
4. Manufacturers:
    a. 3M.
    b. Thomas & Betts.
    c. Panduit.

H. Nameplates:

1. Nameplates: Engraved three-layer laminated plastic, white letters on black background or to match surrounding area.
2. Control components within the control panel shall have nameplates secured with stainless steel screws. Nameplates cannot be attached to the covers of the panel wireways.
3. The enclosure and components on the front cover or interior swing out panels shall be identified by nameplates.
    a. Use standard manufacturer engraved nameplates for all pushbuttons, and selector switches.
    b. Use engraved plastic laminated nameplates for all other devices, displays, keypads, and annunciator LED's.
    c. For NEMA 12, 4, and 4X enclosures, use an epoxy based adhesive to affix nameplates to enclosure cover.
4. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, power supply, relay, terminal strips, and the like mounted inside the panel. The nameplate nomenclature shall match the component names identified in the submittal drawings.
5. Lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP-60.6 (1984) with an intended viewing distance of 3 to 6 feet for external nameplates and 1 to 2 feet for internal nameplates.

I. Control Circuit Breakers:

1. Each 120 VAC control circuit, instrument, or loop shall be powered from an individual control circuit breaker.
2. Din rail mounted using the same DIN rail as used for the terminal blocks.
3. Manual ON-OFF Switch.
4. Rated 240 VAC.
5. Rated 2000 AIC.
6. Current ratings as needed load served.
7. Provide complete nameplate identifying each circuit.
8. As manufactured by:
    a. ABB

b. Phoenix Contact

c. Entrelec

d. Square D

J. Fused Terminals:

1. Isolate all PLC Digital Outputs with fuses.

2. Isolate all PLC Digital Inputs with fuses.

3. Isolate all PLC Analog Inputs and Outputs with fuses.

4. Coordinate fuse size to be as recommended by the manufacturers. For PLCs, the fuse size to be below internal output protection of the PLC output module.

5. Fuses to be terminal block mounted.

6. Furnish nameplate identifying each fused terminal.

7. As manufactured by:

a. Entrelec

b. Phoenix Contact

c. Or approved equal

K. Field / Remote Connections:

1. Field/remote connections shall be made at terminal blocks within the panel.

2. Furnish an individual terminal block space for each wire.

a. Two wires on one terminal block will not be allowed.

3. Furnish an empty wire channel on the backpanel adjacent to the field/remote terminal block strip to be used to route the field/remote wires to the connection terminal blocks.

4. Provide spare terminal blocks as specified herein.

L. Control Voltages:

1. Control voltage shall be supplied via control circuit breakers in the panel.

2. Control power shall be sourced from the 120V power supplied to the panel, unless otherwise noted in the Plans.

3. AC control voltages other than that supplied shall be transformed via a control power transformer within the panel. DC control voltages shall be supplied by AC to DC power supplies, specified herein.

M. Control Power Transformers:

1. Low impedance type.

2. The control power transformers shall have fused over current protection on both the primary and secondary sides of the transformer.

3. Use actual coil power factors in calculating the VA rating of the transformer. Use a power factor of 35% if power factor of coils is unavailable.

4. Determine the continuous VA rating of the transformer based on maximum sealed VA load current from the coils of the starters, relays, and pilot lights. Maximum inrush current shall be calculated based on the maximum inrush of devices that can be energized at one time plus the load presented by the devices already energized, and the actual power factor of the loads. This maximum inrush current must not cause the secondary voltage of the transformer to fall below 85% of rated voltage when the primary voltage has been reduced to 90% of rated voltage. Based on these calculations then actual transformer size shall be the calculated value times 1.5.

N. Transient / Surge Protection

1. Data and Signal Line Protectors to be used on each and every analog input or output, and on each and every data and signal line external connection point:
   a. Provide electronic circuits and components from damaging surge voltage and currents.
   b. Provide protection of signal and data lines associated with computer, data, communications, instrumentation, broadcasting, and industrial control interfaces.
   c. Shall be used directly with EIA standard interfaces:
      1) RS-232
      2) RS-422
      3) RS-423
      4) RS-485
      5) 4-20 mA instrumentation loops.
   d. Repeatedly provide protection against surge currents in excess of 10,000 Amps.
   e. DIN rail mounted.
   f. Cable shields shall be passed through and may be either grounded or not grounded at the protector.
   g. System:
      1) Heavy duty multi-staged protectors.
      2) Solid state stage intercepts the leading edge of the surge with sub-nanosecond response time.
      3) Within micro-seconds, a 3-pole common chambered gas tube capable of handling 20,000 ampere lightning current operates and crowbars the surge to ground.
      4) The protector remains in the crowbar state until the surge has passed and line voltages return to safe levels.
   h. Location:
      1) Place at each end of a signal line, data line, or current loop.

2) In the case of daisy chain configuration, such as RS-485, protectors shall be placed at each node.

i. Electrical Characteristics:

1) Surge Life:

a) Greater than 1000 operations with 200 Amps, 10 x 100 µsec.

b) Greater than 10 operations with 10,000 Amps, 8 x 20 µsec.

2) Leakage current at rate line to ground voltage < 10 µAmps.

3) Signal/Data attenuation at maximum data rate 3 db with 600 terminations.

4) Operating temperature -40°C to +60°C.

j. As manufactured by:

1) Joslyn:

a) For differential signals, such as RS-422 or RS-485, and current loops – Model 1820.

b) For high frequency differential signals and current loops – Model 1821.

c) For line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1810.

d) For high frequency line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1811.

2. Protection from inductive spikes within the control panel.

a. Provide surge protection across all inductive coils for control relays, starters, solenoids, etc.

O. Power Supplies: Power supplies shall convert 120 VAC ±10% to 24 volt DC or other DC voltages as necessary.

1. Power supplies shall have an excess rated capacity of 40 percent or be rated 100 watt minimum.

2. The failure of a power supply shall be annunciated at the control panel and repeated to the SCADA system through a connection to PLC.

3. Output regulation shall be accurate within ±0.05% for a 10% line change or a 50% load change and shall include remote voltage sensing.

4. The power supply shall be rated for temperatures of 32 to 122 degrees F and shall be UL recognized.

5. Power supplies shall have fully isolated primary and secondary coils which shall be surrounded by an insulating enclosure which shall also provide mechanical isolation.

6. All power supplies shall be designed and configured as fully redundant systems so that the failure of one power supply will automatically transfer to the other power supply with no interruption in power.
    a. The power supply failure shall supply a dry contact for connection to a PLC input for an alarm indication.
7. As manufactured by:
    a. Power One W Series.
    b. Phoenix Contact Quint Series.
    c. IDEC Slim Line.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conform to all application provisions of the NEMA and UL standards, NEC and local, state, and federal codes when fabricating the equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Locate devices, including accessories, where they shall be accessible from grade, except as shown otherwise.

C. Mount components in accordance with the installation details as prepared by the manufacturers.

D. Mount equipment so that each device is rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment within the panel.

E. Items, components, devices, and accessories shall be mounted and anchored using stainless-steel hardware, unless otherwise noted.

3.2 SPARES

A. Unused inputs and outputs from the PLC shall be wired to field terminal blocks and identified.

B. Furnish one spare normally open and one spare normally closed dry contact for each push-button, selector switch, relay, etc.

C. Furnish ten spare fuses for each type of fuse in the panel.

D. Furnish 15 spare terminal blocks or 20% whichever is greater.

E. Furnish five spare relays for each type used in the panel.

F. Spare contacts of relays, switches, etc., shall be internally wired to terminal blocks.

END OF SECTION

SECTION 26 24 21 - MOTOR STARTERS

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. Motor Control Systems.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications herein shall apply to all work under this Division 16, including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 28 13 – Fuses
3. Section 26 05 26 – Grounding and Bonding
4. Section 26 09 13 – Control Devices

B. The CONTRACTOR shall be familiar with all sections of these electrical specifications. He shall adapt his work to the work required of other trades to affect a complete and working system. Where this CONTRACTOR furnishes equipment, materials or installation which comprises a part of another CONTRACTOR's system, the item so furnished shall meet or exceed the requirements imposed on the other systems.

1.3 SHOP DRAWINGS/SUBMITTALS

A. Furnish complete working shop drawings of all control systems. Reference design documents for sequence, basic components, suggested piping, wiring, and dimensions. Submit manufacturer's data sheets for all equipment, devices and materials.

B. After initial review, make corrections requested and resubmit in clean format. Work only from final review set.

C. Maintain Record Drawings in the field. Clean up originals at completion of work and resubmit for OWNER's use in operation of the systems.

1.1 CONTROL DIAGRAMS

A. Control diagrams indicating the general control strategy are as shown on the Drawings. Actual circuitry will vary for the specific equipment furnished. Pilot light push-to-test wiring was omitted from the control diagrams for clarity.

B. Clarification of any function or device of any system not fully understood or recognized as being undefined should be requested from the ENGINEER during the bidding period.

1.4 CLEANING AND LUBRICATION

All equipment shall be thoroughly cleaned by the CONTRACTOR before final acceptance. The CONTRACTOR shall provide lubrication for all equipment furnished by him.

1.5 TESTING AND ADJUSTING OF SYSTEM

A. During the testing and adjusting of the various electrical, control, and instrumentation systems, the CONTRACTOR shall have a representative present and available to adjust controls as required. The integrity and accuracy of each function and control point shall be demonstrated and reported.

1.6 CODES AND STANDARDS

A. The following standards shall be considered to be part of this specification insofar as they give definitions and describe requirements and tests which equipment supplied shall meet. They shall be the latest edition, including any addenda, supplements, or revisions thereto, in effect at the time of award of the purchase order. The equipment shall also meet any laws or requirements of the city, state or other regulatory bodies having jurisdiction over such apparatus, unless otherwise specified.

1. ANSI C57.13	Requirements for Instrument Transformers
	ANSI C89.1 (NEMA ST1) Specialty Transformers (except General Purpose Type)
3. NEMA AB-1	Molded Case Circuit Breakers
	NEMA ICS1 General Standards for Industrial Control and Systems
	NEMA 1CS2 Industrial Control Devices, Controllers and Assemblies
6. ANSI C1 (NFPA70)	National Electrical Code
	UL 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures
8. UL 508	Industrial Control Equipment
9. UL 845	Standard for Motor Control Centers
10. UL 1053	Ground Fault Sensing and Relaying Equipment
11. MSHA	Mine Safety and Health Administration

PART 2 - PRODUCTS

2.1 MOTOR CONTROLS NOT IN MOTOR CONTROL CENTERS

A. Furnish NEMA 4X stainless steel with gasketed hinged door control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all components, numerically code all piping and wiring. Terminate all wiring at labeled terminal blocks. Provide engraved plastic labels for all panel face devices.

2.2 MOTOR STARTERS NOT IN MOTOR CONTROL CENTER

A. Furnish stainless steel with gasketed hinged door control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all components, numerically code all piping and wiring. Terminate all wiring at terminal blocks. Provide engraved plastic labels for all panel face devices.

A. Combination magnetic starters shall be sized as indicated on the Drawings and shall be equipped as follows:

1. Motor Circuit Protector.
2. NEMA contactor rating indicated, NEMA size 1 minimum.
3. Control power transformer sized per load installed plus 50% spare capacity. Shall include fused primary and secondary.
4. Solid state overload relay – SymCom Motor Saver 777, Square D Motor Logic Plus, or Ge Multilin, Allen Bradley or equal.
5. Pilot devices and controls as shown on Drawings.
6. NEMA rated enclosure as shown on the Drawings.

C. Manual motor starters shall have:

1. ON pilot light.
2. Overload Protection: Melting alloy type thermal overload relays where indicated or required.
3. NEMA rated enclosure as shown on the Drawings.

PART 3 - EXECUTION

3.1 WIRING

A. All control wiring, 120 volt and below, shall be installed in conduit and wiring boxes.

B. Use no wiring smaller than #14 AWG and no conduit smaller than ¾ inch.

3.2 SPARES

A. Provide one spare manual motor starter for each size and type used.

B. Provide one NEMA size 1 contactor.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

B. Fuses.

C. Spare Fuse Cabinet.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 05 19 – Conductors and Cables

1.3 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Bussmann.

B. Other acceptable manufacturers: Gould Shawmut, Little Fuse.

C. All fuses shall be of one manufacturer. Fuses shall have a 200,000 ampere RMS symmetrical interrupting rating unless noted otherwise.

PART 2 - PRODUCTS

2.1 FUSE TYPES AND RATINGS

A. Fuses from 0 to 600 ampere for each circuit serving a single motor shall be UL Class RK5 dual-element Low Peak, LPN-RK (250 volt), LPS-RK (600 Volt).

B. All other fuses in the 0 to 600 ampere range shall be UL Class RK5, dual-element, time delay, Iow peak, LPN-RK (250 volt), LPS-RK (600 Volt).

C. Fuses larger than 600 ampere shall be UL Class L with time delay, Hi Cap, KRP-C.

D. High voltage fuses - see drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motor circuits shall be fused. Fuses, 0 to 600 amperes, for 1.15 service factor motors shall be sized not exceeding 125% of motor full load amperes shown on nameplate. Fuses, 0 to 600 amperes, for all other motors shall be sized not exceeding 115% of motor full load amperes. Fuses above 600 amperes for all motors shall be sized up to 150% of motor full load amperes. Abnormal motor starting conditions requiring over sizing shall be coordinated with motor

manufacturer.

B. Spare fuses shall be furnished for all fuse types. Spares shall amount to 10% of installed fuses with a minimum of one set of each fuse type and ampere rating. The set shall equal the number of poles in the appropriate switch.

C. Provide Spare Fuse Cabinet equal to Bussmann for storing spare fuses. Mount on wall in Equipment Room as directed by the ENGINEER.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.

2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2010 m).

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

A. Fuses: Bassman, Edison Fusegear, GEC Alsthom, Littel fuse.

B. Switches: Same as manufacturer of project's main panel board.

C. Type HD, Heavy Duty:

1. Single throw.

2. Three pole.

3. 600-V ac.

4. 1200 A and smaller

5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.

6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Mechanical type, suitable for number, size, and conductor material.

7. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

A. Same as manufacturer of Project's main panel board.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Mechanical type, suitable for number, size, and conductor material.

7. Service-Rated Switches: Labeled for use as service equipment.

2.5 SHUNT TRIP SWITCHES

A. Bussman, Square D, Eaton, GE, Siemens.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, Amperage as incidated. A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer source of enough capacity to operate shunt trip, pilot, indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.

2. Oiltight red ON pilot light.

3. Isolated neutral lug; 100 percent rating.

4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.

5. Form C alarm contacts that change state when switch is tripped.

6. Three-pole, double-throw, fire-safety and alarm relay 24-V dc coil voltage.

7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

9. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

10. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

11. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating 120-V ac.

12. Hookstick Handle: Allows use of a hookstick to operate the handle.

13. Lugs: Mechanical type, suitable for number, size, and conductor material.

14. Service-Rated Switches: Labeled for use as service equipment.

2.6 MOLDED-CASE CIRCUIT BREAKERS

A. Same manufacturer as breakers in main panel board.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for the 167 deg F (75 deg C) temperature rating in NFPA 70.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.

2. Long- and short-time pickup levels.

3. Long- and short-time time adjustments.

4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

O. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.7 MOLDED-CASE SWITCHES

A. Same manufacturer as panel boards.

B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

D. Features and Accessories:

1. Standard frame sizes and number of poles.

2. Lugs:

a. Mechanical type, suitable for number, size, trip ratings, and conductor material.

b. Lugs shall be suitable for the 167 deg F (75 deg C) temperature rating in NFPA 70.

3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.8 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) indoor gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12) outdoor.

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall directly operable through the front cover of the enclosure (NEMA 250 Type 1) directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Architect's written permission.

4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Kitchen Areas: NEMA 250, Type 4X stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

B. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in fusible devices.

G. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, grounding, and clearances.

c. Verify that the unit is clean.

d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.

e. Verify that fuse sizes and types match the Specifications and Drawings.

f. Verify that each fuse has adequate mechanical support and contact integrity.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.

i. Verify correct phase barrier installation.

j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify that the unit is clean.

e. Operate the circuit breaker to ensure smooth operation.

f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.

h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable.

Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

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

E. Prepare test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies”.

END OF SECTION

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SECTION 26 28 19 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To

1. Furnish and install disconnects as described in Contract Documents, except those provided integral with equipment.

B. Related Sections

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 05 09 - Electrical Identification
3. Section 26 28 13 – Fuses

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, ratings, and specifications.

B. Refer to Section 26 05 00 for submittal requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturer

1. As shown in drawings.

B. Disconnect Switches:

1. Heavy duty quick-make, quick-break type, fused, unless indicated otherwise. Provide a control switch for VFD fed motors which will disengage the VFD prior to opening the switch.
2. Provide interlock to prevent opening of door when switch is in ON position.
3. Provide means to lock switch in OFF position with padlock.
4. Disconnects for motor circuits shall be horsepower rated.
5. Where indicated on Drawings for small motors, disconnects shall be manual starter with thermal overload relay.
    a. Device shall have one pole per ungrounded conductor of motor.
    b. Provide overload relay to match motor full load amps.
    c. Equip with lockout device.

6. Enclosures:
    a. Interior Dry locations - NEMA Type 1, or upgraded as indicated or required.
    b. Exterior, Damp, or Wet Locations - NEMA Type 3R, or upgraded as indicated or required.
    c. Hose-down areas – NEMA Type 4, or upgraded as indicated or required.
    d. Corrosive areas – NEMA Type 4X Stainless steel, or as indicated or required.
7. Fuses:
    a. Fuse fused disconnects with dual-element time delay fuses and equip with rejection type fuse holders.
    b. Fuses on shall be from single manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Label disconnects to indicate equipment served, such as Condensing Unit CU-1. Use 1/16 inch (1.6 mm) thick laminated plastic composition material with contrasting color core. Engraved letter shall be 1/4 (6 mm) inch high. Attach labels with screws.

END OF SECTION

SECTION 26 29 23 - PULSE WIDTH MODULATED VARIABLE FREQUENCY DRIVE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required and install, place in operation and field test 6 pulse or 18 pulse variable frequency drive.

B. The adjustable frequency controller shall be a flux vector sine-wave, pulse width modulated (PWM) design. A modulation method which incorporates “gear changing” is not acceptable. The final responsibility of the completed drive system is that of the manufacturer. Qualified system integration will be by manufacturers approved and should use methods and procedures approval in writing by the VFD manufacturer prior to shipping the drive system to customer site. One manufacturer shall provide all drives systems under this contract. The drive systems shall be manufactured within the United State of America to alleviate concerns of future spare part availability and technical support. All drive systems shall be purchased and furnished by the CONTRACTOR.

C. Drives for motors up to and including 60 HP shall be 6 pulse configured with harmonics filtration. Drives over 60 HP shall be 18 pulse type or achieve equivalent harmonics results.

1.2 QUALITY ASSURANCE STANDARDS

A. The entire VFD system as described herein shall be assembled and factory tested to assure a properly coordinated system.

B. Codes: Provide equipment is full accordance with the latest applicable rules, regulations, and standards of:

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electrical Code (NEC).
4. Underwriters Laboratories (UL).
5. American National Standards Institute (ANSI).
6. National Electrical Manufactures Association (NEMA).
7. Institute of Electrical and Electronic Engineers (IEEE).

C. The complete drive system shall be UL listed.

D. The manufacturer will have a minimum of 12 years experience in Integrated Bi-polar Transistor technology.

1.3 ACCEPTABLE EQUIPMENT MANUFACTURERS

A. ALLEN BRADLEY

B. TOSHIBA INTERNATIONAL CORPORATION

C. ROBICON CORPORATION

D. CUTLER-HAMMER

E. DANFOSS

F. ABB

G. SQUARE D

H. GENERAL ELECTRIC

I. BENSHAW

J. MITSUBISHI

FOR THE BOOSTER, IT IS PREFERRED TO MATCH THE SAME MAKE AND MODEL (OR MODEL FOR REDUCED HP) AS THE EXISTING VFD'S IN THE BUILDING, BUT ONE OF THE ACCEPTABLE MODELS WILL BE PERMITTED.

1.4 SUBMITTALS

A. Submittals shall conform in all respect to this section.

B. Submittals shall be prepared specifically for this project by the VFD manufacturer. For this specific application submittal package will be due three weeks upon request.

C. Submittal information shall include, but not be limited to:

1. Equipment dimensions, including stub-up locations, shipping split and shipping weights.
2. Approval electrical drawings, termination drawings and component location diagrams.
3. Manufactures equipment specification.
4. Catalog cut sheets of major components.
5. Spare parts list, per Paragraph 3.03.
6. Certifications, including:
    a. Warranty, per section 1.04
    b. Efficiencies, per section 2.02. A.1.
    c. Harmonic distortion analysis study, per section 2.01E.

1.5 WARRANTY

A. All equipment furnished under this section shall be warranted for all parts and labor by the CONTRACTOR and the original equipment manufacturer for a period of not less than one (1) year from the date of startup.

B. The manufacturer shall meet the quality and program requirements of ISO 9001.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Any modification to the standard product required to meet this specification shall be performed by the VFD manufacturer or approved systems integrator only. Distributors and panel manufactures changes to the VFD products are specifically disallowed.

B. The VFD system shall consist of harmonic filter unit, input rectifier-grade phase shifting transformer, converter section, output inverter and control logic. All components shall be wired and tested together as a complete system. The labor and materials for field interconnection of the system are to be provided by the VFD manufacturer. Each drive shall be designed for stand alone operation. Multiple drive units shall not utilize shared components. The drive shall be housed in a free standing, front accessible, general purpose indoor enclosure rated NEMA 12, gasketed, with fans and filters. Cabinets shall be single or multi-bay, sheet steel with hinged doors. Doors will have concealed hinges with lockable through-the-door handle operator mechanism. Provisions shall be made for top or bottom entry/exit of incoming line power cables, outgoing load cables and control wiring. All VFD's shall include DC link reactors.

C. Each VFD shall have a molded case, circuit breaker type main power disconnect switch, with an external operating handle. The circuit breaker and the drive unit shall have a minimum short circuit rating of 42,000 amperes RMS symmetrical interrupting capacity and shall be labeled in accordance with UL Standard 489.

D. The following safety features shall be standard on all drives:

1. Provisions to padlock main disconnect handle in the "OFF" position.
2. Mechanical interlock to prevent opening cabinet door with disconnects in the "ON" position, or moving disconnect to the "ON" position while the unit door is open.
3. Auxiliary contact on main disconnects to isolate control when fed from external source.
4. Barriers and warning signs on terminals that are energized with the power disconnect "OFF".

E. Any VFD over 60 horsepower shall meet all requirements as outlined in the 2014 edition of IEEE 519 for each individual and total harmonic voltage and current distortion and as indicated in this specification. As per Table 10.2 of IEEE 519-2014, individual or simultaneous operation of the VFD's shall not add more than 3% total voltage harmonic distortion while operating at full load and speed from the utility source, or more than 5% while operating from a standby generator (if applicable).

1. The VFD manufacturer cannot predict or be responsible for pre-existing voltage distortion on the line or distribution from sources supplied by others. Maximum input voltage unbalance shall be .5% as defined in NEMA MG1 section 14.35.2.
2. As per Table 10.3 of IEEE 519-2014, maximum allowable total harmonic current demand distortion limits for each VFD operation at full load and speed shall not exceed 5% as calculated and measured at the point of common coupling Isc/II>20).
3. The point of common coupling for all harmonic calculation and field measurement for both voltage and current distortion shall be defined as the main bus feeding each drive.

4. The short circuit current used for harmonic calculations shall be defined as the total full load current with all VFD's operating multiplied by twenty. Example (5) 100 HP VFD's Full load current = 5 x 126 amps = 630 amps. Short circuit current = 20x 630 amps = 12600 amps.
5. If harmonic filters are required to meet these requirements, the VFD manufacturer must provide as a minimum 5th, 7th, and 11th harmonics filters and is responsible for the design and manufacturing of the filters. The vendor must supply cabling and installation for the filters. The filters are to be provided with a separate contactor such that the VFD can operate in the event of a filter failure. Failure of a filter shall not cause the entire drive system to shutdown.

F. Harmonic compliance shall be verified with onsite field measurement of both the voltage and current harmonic distortion on the main bus of the VFD termination without the VFD in operation. A recording of harmonic analysis displaying individual and total harmonic currents and voltage must be utilized.

G. VFD system shall maintain a 95 minimum true power factor throughout the entire speed range.

H. Displacement power factor shall be .95 percent or higher throughout the entire operating speed range, measured at drive input terminals.

I. For motors over 200hp, the drive shall include an RTD monitoring module which shall monitor 8 – 100 ohm platinum RTD's in the motor. The RTD module shall provide a trip and an alarm contact. The RTD alarm contact shall cause an alarm light to illuminate on the VFD front panel. The RTD Trip contact shall cause the VFD to trip, and send the trip status to the PLC. The alarm and trip contacts shall be settable and adjustable to variable trip and alarm settings.

J. For Motors under 200hp, the drive shall monitor overtemperature using temperature monitoring equipment to cause a trip and alarm.

K. Variable Frequency Drive Ratings:

1. The minimum drive efficiency for NEMA 12 enclosed drive shall be 95.0 percent or better at motor base speed and rated torque. Losses shall include all control power and cooling system losses associated with the drive as well as the input phase shifting transformer.
2. Input Power rating shall be 400-460VAC, plus 10 percent, minus 10 percent, 3 phase, 60 Hz, plus 2, minus 2 Hertz.
3. The voltage ride through of the VFD shall be capable of sustaining continued operation with a 40% dip in normal line voltage. Output speed may decline only if current limit rating of VFD is exceeded.
4. Power loss ride through of the VFD shall be capable of a minimum of 3 cycles loss.
5. The output power shall be HP, 460 Volt, 3 Phase, 60 Hertz, per motor nameplate FLA at installed altitude plus service factor of 25%.
6. The operating ambient Temperature -10 to 40°C (14 to 104°F).
7. The storage temperature shall be -20 to 60°C (4 to 140°F).
8. The relative operating humidity shall be 0 to 95% Non-Condensing.

9. The site operating vibration condition shall be acceleration at 0.6 G maximum (10-55 Hz). Amplitude at 0.1mm maximum (50-100 Hz).
10. Drives shall be sized/de-rated to operate at full load at an elevation of 4700 ft.
11. Power unit rating bases shall be 100% rated current continuous and 120% for one minute at rated temperature.

2.2 CONSTRUCTION

A. The controller shall produce an adjustable AC voltage / frequency output. It shall have an output voltage regulation to maintain correct output V/Hz ratio despite incoming voltage variations.

B. The controller shall have a continuous output current rating of 100% of the motor nameplate rating as a minimum.

C. The converter section will incorporate three distinct diode bridges configured in a series connection. The series connection will provide continued balance of the bridges to insure the harmonic litigation remains consistent throughout the life of the drive. The input to the diode bridges will be a full phase shifting isolation transformer with multiple secondaries. The variable frequency drive system shall also include a filter network and a transistorized inverter section. The drive manufacturer will also manufacture the Transistors used in the inverter section of the drive to reduce harmonics to flow back to the incoming power source.

D. The inverter output shall be generated by to be Insulated Gate Bipolar Transistors (IGBT's) with a PIV rating of 1200 volts minimum. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor lines current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for a pure sin wave operation.

E. The controller (s) shall be suitable for operating standard NEMA Design-B induction squirrel-cage motor having a 1.15 service factor. The drive can be located up to 300 feet from the motor without requiring special cabling or a separate motor protection devices. Motor nameplate information shall be provided by the CONTRACTOR, prior to contract award to the VFD manufacture to properly size the inverter. In the future, is shall be possible to substitute any standard inverter rate motor (equivalent house power, voltage and RPM) in the field. Output filters shall be installed for motors over 300 foot from VFD.

F. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors. A power failure will not necessitate a reload of any drive parameter or configuration.

2.3 BASIC FEATURES

A. The door of each adjustable speed drive system shall include an operator interface station (OIT/HMI) and key pad with a manual speed device. Each drive shall have operator interface devices at a minimum as called out in the drawings.

B. For safety the drive will require manual restart for customer programmable faults. The fault displays shall include over current, over voltage, heat sink overheat, load side short circuit, load-side ground fault, inverter overload, stator over-current during start-up, load-side over current during start-up, EEPROM error, RAM error, ROM error, communication error, (Dynamic braking resistor over current), Under voltage, low current, over torque, lose of phase, and motor overload.

C. The door mounted operator interface shall be capable of controlling the VFD and setting the drive parameters. The key pad shall have the following programming features:

1. The digital display must present all diagnostic messages and parameters values in English engineering units when accessed.
2. The digital interface keypad shall allow the operator to enter exact numerical settings in engineering units. A plain English user menu (rather than codes) shall be provided in software in nonvolatile memory as a guide to parameter setting and reset table in the field through the key pad. The drive set up parameters must be able to be transferred to new boards to reprogram spare boards.
3. The VFD shall have the capabilities of communicating via network to the PLC. All status shall be communication to the PLC including 3 phase voltage, 3 phase current, speed, status alarms, errors, etc.
4. Programmable output relay contacts and inputs shall be rated for 250 VAC, 2 Amps. A separate 24 VDC power supply (50 mA) shall be available to control exterior control devices. Programmable analog output signals shall be available to meet system requirements. Programmable analog input speed signals shall be available to accept a speed command.
5. The principle output frequency shall be programmable from 0-400 Hz and acceleration / deceleration from .1 to 6000 seconds. The PWM carrier frequency shall be adjustable from .5 to 15 kHz and shall be self adjusting.
6. The VFD shall have internal to the drive a proportional gain; integral gain anti-hunting gain, lag time constant and PID error limit adjustments. This shall be programmable through the key pad.

2.4 ENCLOSURE

A. All VFD components shall be factory mounted and wired on a dead front, grounded indoor NEMA Type 12, gasketed enclosure. It shall be suitable for mounting on a concrete house keeping pad. The steel enclosure shall have a minimum of two-layer of primer and one-layer of industrial finished Sherwin Williams Precision enamel paint or equal.

B. A forced air cooling system will automatically start and stop as necessary to extend the life of the fan.

C. VFD systems shall be stand alone system with an integral through the door mounted disconnect switch operator.

D. The dimensions of the VFD enclosure shall be maximum 36” wide, 24” + 8” depth, 90” height.

2.5 PROTECTIVE FEATURES AND CIRCUITS

A. The VFD shall have the following additional protective features that will protect against damage to the motor, load conductor, contactors or solid state soft starts and the VFD internal devices and electronics.

B. Three phase short circuit on the VFD output terminals.

C. Losses of input power due to opening VFD input disconnect device or loss of utility power during VFD operation.

D. A loss of one (1) phase of the input power shall cause the drive to trip off protecting the drive systems electronics.

E. The VFD will run without connection to the motor load.

F. The VFD shall sense an output short circuit that may occur during operation.

G. The key pad display shall provide a minimum of the last 50 system faults.

H. There shall be stall protection on an overload condition with inverse time overcurrent trip. Current limits shall be adjustable from 10 to 215% of the drive current.

2.6 PARAMETER SETTINGS

A. The following system configuring setting shall be provided and field adjustable, without exception, through the keypad/display unit. Except for motor nameplate data, all parameters must be adjustable while the processor is on-line and the drive is running.

1. Motor Nameplate Data.
2. Motor Full Load Amps.
3. Motor Frequency.
4. Number of poles.
5. Full Load RPM’s.
6. Motor Voltage.
7. Operating current limits. – Min/Max.
8. VFD Configuration Parameters.
9. Independent accel/decel rates.
10. Min./Max. speed (Frequency
11. Forward or Reverse operation.
12. Catch a spinning load selection.
13. Preset Speed capabilities.
14. Volts per Hertz ratio.

15. No load / Full Load boost.
16. Over current trip selection.
17. Frequency jump selection.
18. Programmable meter output signals (Hz. Speed, RPM, Voltage, Torque, PID feed back, input/output power, and DC bus voltage.

B. Automatic Control

1. 4-20 mA input control signal.
2. PID internal or external set point capabilities.
3. Programmable preset speed operational run conditions.
4. Automatic load reduction during overload condition or soft stall.
5. Programmable loss of signal control: Stop, maintain speed or default to preset speed or set point.

C. All drive setting adjustable and operation parameters shall be restored in a parameter log which allows minimum and maximum points as well as the present set values. This parameter log shall be accessible via a RS-232 or RS485 serial port or other communications method as well as on the keypad or internal to the drive.

D. The drive shall have the following inputs/output features that will provide control and monitoring of the VFD. The analog outputs shall be isolated as required by this specification.

1. Three programmable analog outputs.
2. Two programmable analog inputs. The 4-20mA analog input speed reference signal will be galvanically isolated. Calibration adjustments shall be provided by the keypad.
3. 4-groups of 8 pattern runs or 32 pattern runs shall be available.
4. Three programmable digital output (form C, dry contact relays)
5. One potential pot input (three wire control) +10 V, wiper and common, if specified in drawing.
6. System control program providing built–in drive control or application specific configuration capabilities.
7. Input / output function shall match those indicated in the drawings.
8. Minimum / maximum dry contact output.

2.7 DIAGNOSTIC FEATURES AND FAULT HANDLING

A. The VFD shall include a comprehensive microprocessor based digital diagnostic system that monitors its own control functions and displays faults and operating conditions.

B. A “Fault Log” shall be accessible through the keypad digital illustrations in English. The display shall be capable of illustrating 50 past faults. Optional output shall be through the serial port link. All drive possible fault conditions will be accessible through the fault log.

2.8 DRIVE OPTIONS

A. For drives located more then 300 feet from motor, the drive shall be modified to include a factory or SI wired output line reactor.

B. Information included elsewhere:

1. Drive feed location – See Drawings.
2. Drive overall dimensions allowed – See Drawings.
3. Additional control information – See Drawings.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The drives will be completely assembled, wired, and tested in the United States of America. The following tests will be performed:

1. The manufacturer shall use the ISO-9001 standards in the purchase, engineering, manufacturing and testing of the VFD system.
2. Upon completion of manufacture and assembly, the drives shall be subjected to a complete factory test to demonstrate compliance with specified features and characteristics of the specification. The purchaser at his option shall be able to witness factory testing of his unit, with factory coordination.
3. The testing procedure shall be the manufacturer’s standard procedure (except for loss of phase) to assure maintenance free service. The buyer shall be given a 5 day notice prior to the start of factory testing for the buyer's representative to witness the testing.
4. All equipment, devices, instrumentation, and personnel required to perform the factory tests shall be supplied by the manufacturer. Upon satisfactory completion of the test, the seller shall upon request submit two (2) certified copies of the test report to the buyer. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.
5. A loss of each phase testing shall be conducted at the factory to guaranty the safe and orderly shutdown of the drive under load. These tests shall conclude that the drive will not fail its electronic circuits or causes sever over heating of the bridges. These tests shall not limit the life of the drive system. There are no exceptions to this test. This test shall be performed and test reports provided to the ENGINEER prior to installation of the drive system package.

3.2 STARTUP AND FIELD TESTING

A. The VFD manufacturer shall provide the services of a factory trained technician for startup assistance, programming and testing. Verification of the VFD input harmonics voltage and current distortion limits specified must be verified as part of the start-up and acceptance. If harmonics distortion requirements are not met, it is the responsibility of the VFD supplier to meet these specifications at the manufacturer's expense. Meg-ohm testing will be done to the load conductors and motor to verify condition of the equipment prior to startup. The VFD manufactures shall certify the VFD and motor system as compatible. UL508 technicians shall not be allowed to perform startup procedures.

B. A 10% payment retention will be released upon factory field test verification of harmonic specifications requirements and final test report and acceptance.

C. Spare Parts

1. The following spare parts shall be furnished. The net price per item shall be provided with the request for proposal. Each spare part shall be package and identified by part number and type for long term customer storage.

    a. Three of each type of fuse rated 480 Volts or less.

    b. Two of each type of converter power semi-conductor.

    c. Two of each type of inverter power semi-conductor.

    d. One of each type of control board, gate firing board and communication board.

    e. One key pad assembly.

    f. OR Replacement VFD for items b. through e.

    g. Five of each type of panel lamp.

    h. Three of each size MOV's.

END OF SECTION

SECTION 26 80 10 - HVAC SYSTEMS CONTROL

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. Electrical work associated with the systems including, but not necessarily limited to:

1. All electrical installation including power distribution and special systems, is included in the scope of the general contract. Of specific concern are the control systems related to mechanical equipment. Responsibility for the control work is divided between the project electrician (Division 26) and his controls sub-contractor. HVAC related I/O and Control as indicated in drawings.
2. All electrical work shall be in accordance with Division 26.
3. Division 26 shall provide all power to and throughout the building, to include motor control centers, breaker panels, and all other systems designated to Division 26, and specified herein. Division 26 shall install all conduit systems.
4. Division 26 shall run and connect all wiring and devices which power or control motors and other mechanical or control devices. Where control devices are located in power circuit, the controls contractor shall interrupt the circuit in the mechanical equipment junction box, wire through the control device and back to the junction box.
5. Breakers and disconnects, auxiliary contacts, standard pilot lights and magnetic starters are the responsibility of Division 26 and shall be as specified herein.
6. Auxiliary relays, low voltage transformers, control panel switches and devices, thermostats, pressure switches, electric operated valves, etc., are the responsibility of Division 26.
7. All wiring shall terminate at labeled terminal strips.

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

A. Section 26 05 00 - Electrical General Requirements.

B. Section 26 05 19 – Conductors and Cables.

1.3 SUBMITTALS

A. Reference Section 26 05 00

B. The controls contractor shall provide shop drawings for control system circuits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Terminal Blocks: DIN rail mounted, modular type, single layer, non-fused. Entreloc or approved equal.

B. Twisted, Shielded Pair Conductors for Control Wiring: Conductors shall be copper with 100 % shielding, plenum rated. Beldon type 89418 or approved equal. Cables shall be run in conduit.

C. Conductors: All control conductors shall be #14 AWG THWN minimum.

D. Labeling: All control conductors shall be labeled with a number corresponding to the mechanical control system drawings. All labeling shall be heat-shrink ink printed type by Panduit Pan-Quick LS3 system or equal.

PART 3 - EXECUTION

3.1 GROUNDING

A. Labeling: All control conductors shall be numerically labeled corresponding to the mechanical control systems record drawings.

B. Grounding Lugs: Ground all shielded pair shields at one end only to avoid ground loops. At terminal block connections, the shield shall be continuous from one conductor to another and shall be isolated from the local ground plane.

C. Conductors: All conductors shall be run in conduit unless specifically noted otherwise. The minimum size of conduit shall be 3/4" unless specifically noted otherwise.

END OF SECTION

SWGWTP AND EDUCATION CENTER
HVAC IMPROVEMENTS

AT

JORDAN VALLEY WATER CONSERVANCY DISTRICT

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

JVWCD PROJECT NO. 4287

PREPARED BY:

HEATH
Engineering Company

377 West 800 North Salt Lake City, Utah 84103
Tel: (801) 322-0487 Fax: (801) 322-0490

November 14, 2023
CONSTRUCTION DOCUMENTS

DRAWING INDEX

EXISTING REFRIGERANT MANAGEMENT UNIT (RMU)

COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	126	COOK 16x36 GI	PIPING CONNECTIONS				MAX. DIMENSIONS				MANUFACTURER MODEL
							COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	COOK 16x36 GI	
RMU-1	MAIN ENTRY	189	106	5	0.55	208 1PH	3/8	5/8	1-1/8	7/8	72	71	26	12	MITSUBISHI CMB-P105NUGA
RMU-1	OFFICES	189	106	8	0.85	208 1PH	3/8	5/8	1-1/8	7/8	84	71	26	12	MITSUBISHI CMB-P108NUGA
RMU-1	MEETING ROOMS	189	106	5	0.55	208 1PH	3/8	5/8	1-1/8	7/8	72	71	26	12	MITSUBISHI CMB-P105NUGA

EXISTING PUMP SCHEDULE (P)

PLAN CODE	TYPE	DUTY	FLOW (GPM)	PRESSURE (FT)	PUMP SPEED (RPM)	MIN. EFF. (%)	FLUID	MOTOR				PUMP & MOTOR WT. (LBS)	MANUFACTURER & MODEL NO.	REMARKS
								LOAD (BHP)	SIZE (HP)	EFF. (%)	VOLTAGE & PHASE			
P-1,2	VERICAL INLINE	C-1,2,3	100	46	1750	65	WATER	18	3	PREM.	208/3	100	BELL & GOSSET 90 2A	PROVIDE WITH VFD
P-3	CIRC.	WH-1 SOLAR	2	51	2650	-	WATER	0.08	1/3	-	120/1	15	VIESSMANN -	PROVIDE BY SOLAR MANUFACTURER
P-4	CIRC.	WH-1 RECIRC.	2	10	2650	-	WATER	0.08	1/4	-	120/1	15	BELL & GOSSET PL-30	-
P-5	CIRC.	WSHP-1	15	20	1750	40	30% PPG	0.19	1/2	-	120/1	65	BELL & GOSSET 60, 1-1/4 x 5-1/4	-
P-6	CIRC.	WSHP-1	15	20	1750	40	30% PPG	0.19	1/2	-	120/1	65	BELL & GOSSET 60	-

EXISTING SOLAR COLLECTOR SCHEDULE (SC)

PLAN CODE	TYPE	FLOW RATE (GPM)	ΔP (FT. WG.)	OPTICAL EFFICIENCY (%)	DIMENSIONS			WEIGHT (LB)	MANUFACTURER & MODEL NO.	REMARKS
					WIDTH (IN.)	HEIGHT (IN.)	DEPTH (IN.)			
SC-1 SC-2	FLATPLATE	0.8	2	79	42	94	4	150	VIESSMANN VITOSOL 200F SVZ	-

EXISTING HEAT EXCHANGER SCHEDULE (HX)

PLAN CODE	SYSTEM SERVED	HOT WATER SIDE				COLD WATER SIDE				FOULING RESISTANCE	TYPE	MAUFACTURER & MODEL NO.
		GPM	EWT/LWT °F	P.D. (FT.)	% GLYCOL	CAP. (MBH)	EWT/LWT °F	GPM	P.D. (FT.)	% GLYCOL			
HX-1	NON POTABLE WATER	100	70/60	2.3	-	13.4	50/60	100	23	-	0.0001	BRAZED PLATE	FLAT PLATE 10x20L

SYMBOL LEGEND

SYMBOL	DESCRIPTION
	SUPPLY DUCT (CROSS SECTION)
	RETURN AIR OR EXHAUST DUCT (CROSS SECTION)
	ROUND DUCT (CROSS SECTION)
	RISE OR DROP IN ROUND OVAL DUCT
24"x12"	DUCT SIZE, INSIDE CLEAR DIMENSION IN INCHES
RISE	DUCT RISE
	DROP OR RISE IN SUPPLY DUCT
24"x12"x1"SW	ACCOUSTICAL LINING IN DUCT INSIDE CLEAR DIMENSION IN INCHES
	TURNING VANES IN DUCT
H.D.	HAND DAMPER
F.S.D.	COMBINATION SMOKE/FIRE DAMPER
A.D.	ACCESS DOOR FOR FIRE DAMPER
	SUPPLY AIR DIRECTION
	RETURN AIR OR EXHAUST DIRECTION
	SUPPLY DIFFUSER
	RETURN AIR GRILLE
	EXHAUST GRILLE
	BRANCH DUCT TAKE-OFF
	PARALLEL BLADE DAMPER
	OPPOSED BLADE DAMPER
S	TEMPERATURE SENSOR
	DROP IN PIPE
	RISE IN PIPE
	VALVE IN RISE
—S—	REFRIGERANT SUCTION LINE
—L—	REFRIGERANT LIQUID LINE
—D—	DRAIN
	SOLENOID VALVE
SD	DUCT SMOKE DETECTOR
S.A.	SUPPLY AIR
R.A.	RETURN AIR / RELIEF AIR
EXH.	EXHAUST AIR
NK	DIFFUSER OR RETURN AIR GRILLE NECK

EXISTING COMPRESSOR UNIT SCHEDULE (C) - TO BE REMOVED

PLAN CODE	SOUND dB(A)	COMPRESSOR	COMPRESSOR #	CONDENSER WATER		COOLING CAPACITY			HEATING CAPACITY			DIMENSIONS H x W x L	VOLTAGE / PHASE	REFRIGERANT	REFRIGERANT (LB)	PIPING CONNECTIONS		MAX. INDOOR UNITS	MANUFACTURER & MODEL NO.	MAX. WEIGHT	REMARKS
				FLOW (GPM)	ΔP (FT. WG.)	TOTAL BTU/h	EER	POWER kW	TOTAL BTU/h	COP	POWER kW					LIQUID PIPES	SUCTION GAS				
C-1, C-2 C-3	47	SCROLL	1	25.4	7	96,000	-	6.95	107,000	-	6.84	71 x 22 x 39	208/3	R410A	17	7/8"	3/4"	19	MITCHUBISHI PQRY-P96TGMU-A	594	PROVIDE WATER FILTER LAKOS HTX-0130

HEAT PUMP (HP) - EDUCATION CENTER

SYMBOL	HEATING CAPACITY MBH	COOLING CAPACITY MBH	SUCTION TEMP. °F	ELECTRICAL CHARACTERISTICS			REF.	MAX. UNIT SIZE H x W x L	MCA AMPS	MOCP AMPS	E.E.R.	MITSUBISHI MODEL	REMARKS
				VOLTS	HERTZ	PHASE							
HP-1	108	96	45	208	60	3	R410A	72" x 49" x 30"	44.0	70	12.5/14.5	PUHY-HP96TNU-A	VERIFY WITH SUPPLIER COMPATIBILITY WITH EXISTING EQUIPMENT PRIOR TO PURCHASING
HP-2	108	96	45	208	60	3	R410A	72" x 49" x 30"	44.0	70	12.5/14.5	PUHY-HP96TNU-A	VERIFY WITH SUPPLIER COMPATIBILITY WITH EXISTING EQUIPMENT PRIOR TO PURCHASING
HP-3	108	96	45	208	60	3	R410A	72" x 49" x 30"	44.0	70	12.5/14.5	PUHY-HP96TNU-A	VERIFY WITH SUPPLIER COMPATIBILITY WITH EXISTING EQUIPMENT PRIOR TO PURCHASING

SEE SPECIFICATION 232300

EXISTING ENERGY RECOVERY VENTILATOR (ERV)

PLAN CODE	AIR STREAM	CFM @ ELEV.	S.P. (INWC)	FAN RPM	Bhp (HP)	MOTORS				ELECTRICAL			DIMENSIONS				MANUFACTURER & MKODEL NO.	ACCESSORIES
						HP	RPM	VOLTS/PH HZ	MOUNTED	ERV FULL LOAD AMPS	MIN. CIRCUIT AMPS	MOCP	HEIGHT	WIDTH	LENTH	WEIGHT		
ERV-1	SUPPLY	2,500	0.8	1650	3.1	5	1750	208/3/60	YES	3.5	126	45	62	61	62	675	RENEWAIRE HE3XINV	ERV WILL BE RUN ON VFD
	EXHAUST	2,500	0.5	1545	2.9	3												

EXISTING WATER-TO-WATER HEAT PUMP SCHEDULE (SCHP) - TO BE REMOVED

PLAN CODE	REFRIGERANT	NOMINAL TONS	COOLING											126			126			MAUFCTURER & MODEL #
			LOAD				SOURCE					POWER kW	COP	VOLTAGE/ PHASE	126		MCA	MFS	LxWxH (IN.)	OPERATING WT. (LBS)	COOK 16x36 GI	
			FLOW (GMP)	P.D. (FT.)	LFT (°F)	CAPACITY (MBH)	FLOW (GPM)	P.D. (FT.)	FLUID	EFT (°F)	HEAT ABSORBED (MBH)				RLA	LRA						
WSHP-1	R410A	6	15	12.4	45	70	20	10.8	30% PG	50	92	3.58	3.39	208/3	19.3	129	24.2	40	24x33x25	1500	-	FLORIDA HEAT PUMP WW072-03

NOTE: FURNISH WITH FACTORY STARTERS. FACTORY MOUNTED FUSIBLE DISCONNECTS, AND FACTORY HOSE KIT.

AIR TO WATER HEAT PUMP (HP) - EDUCATION CENTER

SYMBOL	HEATING CAPACITY @5°F MBH	COOLING CAPACITY @100°F MBH	FLOW RATE GPM	ELECTRICAL CHARACTERISTICS			REF.	MAX. UNIT SIZE H x W x L	MCA AMPS	MOCP AMPS	E.E.R.	ARCTIC AIR MODEL	REMARKS
				VOLTS	HERTZ	PHASE							
HP-4	34.8	40.8	11.3	208	60	1	R410A	53-3/4"" x 45-3/4" x 18-3/4"	40.7	50	12.5/14.5	0502A	TWO UNITS REQUIRED - SEE PLANS

SEE SPECIFICATION 236100

EXISTING VRV FAN COIL UNIT SCHEDULE (WSHP)

PLAN CODE	AREA SERVED	AIR FLOW CFM	SOUND LEVEL dBA	VOLT / PH	PLA	COOLING MBH	HEATING MBH	THERMOSTAT TYPE	PIPE CONNECTIONS			FC-1A				FILTERS	FILTERS SIZE	MANUFACTURER & MODEL NO.	NOTE / ACCESSORIES
									LIQUID	GAS	DRAIN	DEPTH (IN.)	WIDTH (IN.)	HEIGHT (IN.)	OPERATING WT. (LBS)				
FC-1A	LOBBY	1,850	-	208/1	2.38	27.4	27.7	SIMPLE MA	5/8	3/8	3/4	21	21	48	86	AMAIR 1300	24x24x4	MITSHUBISHI PVFY-P30E00A	- - -
FC-1B	LOBBY	1,850	-	208/1	2.38	27.4	27.7	SIMPLE MA	5/8	3/8	3/4	21	21	48	86	AMAIR 1300	24x24x4	MITSHUBISHI PVFY-P30E00A	- - -
FC-1C	LOBBY	1,850	-	208/1	2.38	27.4	27.7	SIMPLE MA	5/8	3/8	1-1/4	21	21	48	86	AMAIR 1300	24x24x4	MITSHUBISHI PVFY-P30E00A	- - -
FC-1D	MAIN ENTRY	1,850	44	208/1	2.21	18.8	27.7	SIMPLE MA	5/8	3/8	1-1/4	36	47	15	86	AMAIR 1300	24x24x4	MITSHUBISHI PEFY-P36NMHU-E	- - -
FC-2	SHOP	1,005	39	208/1	0.96	19.4	14.4	SIMPLE MA	5/8	3/8	1-1/4	29	45	12	86	AMAIR 1300	24x24x4	MITSHUBISHI PDFY-P-24NMU-E	- - -
FC-3	BREAK ROOM	200	36	208/1	0.68	4.7	5.5	SIMPLE MA	1/4	1/2	1-1/4	29	28	12	57	AMAIR 1300	12x24x4	MITSHUBISHI PDF-P06NMU-E	- - -
FC-4	OPEN OFFICE	550	39	208/1	0.85	10.7	13	SIMPLE MA	1/4	1/2	1-1/4	29	39	12	71	AMAIR 1300	12x24x4	MITSHUBISHI PDFY-P15NMU-E	- - -
FC-5	CONFERENCE	475	36	208/1	0.68	9.1	5.8	SIMPLE MA	1/4	1/2	1-1/4	29	28	12	60	AMAIR 1300	12x24x4	MITSHUBISHI PDFY-P12NMU-E	- - -
FC-6	OFFICE 109	200	36	208/1	0.68	3.8	2.9	SIMPLE MA	1/4	1/2	1-1/4	29	28	12	57	AMAIR 1300	12x24x4	MITSHUBISHI PEFY-P06NEMU-E	- - -
FC-7	OFFICE 110	200	36	208/1	0.68	3.8	3.1	SIMPLE MA	1/4	1/2	1-1/4	29	28	12	57	AMAIR 1300	12x24x4	MITSHUBISHI PEFY-P06NEMU-E	- - -
FC-8	OFFICE 111	200	36	208/1	0.68	3.8	27.7	SIMPLE MA	1/4	1/2	1-1/4	29	28	12	57	AMAIR 1300	12x24x4	MITSHUBISHI PEFY-P06NEMU-E	- - -
FC-9	WOMENS	165	41	208/1	0.27	2.2	3.8	SIMPLE MA	1/4	1/2	1-1/4	9	42	25	51	AMAIR 1300	12x24x4	MITSHUBISHI PEFY-P06NEMU-E	- - -
FC-10	MENS	165	41	208/1	0.27	2.2	3.6	SIMPLE MA	5/8	3/8	1-1/4	9	42	25	51	AMAIR 1300	12x24x4	MITSHUBISHI PEFY-P06NEMU-E	- - -
FC-11	WARMING KITCHEN	440	36	208/1	0.68	7.2	8.7	SIMPLE MA	1/4	1/2	1-1/4	29	28	12	60	AMAIR 1300	12x24x4	MITSHUBISHI PDFY-P12NMU-E	- - -
FC-12	MEETING ROOM 124	1,525	-	208/1	1.71	29.7	21.4	SIMPLE MA	5/8	3/8	3/4	21	21	48	120	AMAIR 1300	12x24x4	MITSHUBISHI PVFY-P36E00A	- - -
FC-13	MEETING ROOM 125	1,535	-	208/1	1.71	30	21.6	SIMPLE MA	5/8	3/8	3/4	21	21	48	120	AMAIR 1300	24x24x4	MITSHUBISHI PVFY-P36E00A	- - -
FC-14	MEETING ROOM 126	1,890	-	208/1	1.71	37.5	28.1	SIMPLE MA	5/8	3/8	3/4	21	21	48	120	AMAIR 1300	24x24x4	MITSHUBISHI PVFY-P36E00A	- - -

HEATH Engineering Company

STAMP

LICENSED PROFESSIONAL ENGINEER No. 270896 ROBERT JACK KESLER 5/31/23 STATE OF UTAH

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	RJK
DRAWN BY:	KGM
DATE:	November 14, 2023

SHEET DESCRIPTION

EDUCATION CENTER

MECHANICAL SYMBOL LEGEND AND SCHEDULES

SHEET NUMBER

M-001

EXISTING AIR SEPARATOR (AS)

PLAN CODE	SYSTEM SERVED	CONNECTION SIZE	MAX. GPM	P.D. (FT)	MAX. DIMENSIONS			DRY WT (LBS)	MAX. OPER. WT. (LBS)	MANUFACTURER & MODEL NO.
					DIA.	H	FLANGE TO FLANGE (IN.)			
AS-1	SOLAR WATER	4"	132	.5	8.6	23.4	20.1	60	94	SPIROVENT JUNIOR -
AS-2	CHW/HW	4"	132	.5	8.6	23.4	20.1	60	94	SPIROVENT JUNIOR -
AS-3	CONDENSER WATER	4"	132	.5	8.6	23.4	20.1	60	94	SPIROVENT JUNIOR -

EXISTING CONTROL VALVE SCHEDULE (V)

PLAN CODE	SERVICE	TYPE	FLOW (GPM)	Δ P (PSI)
V-1	C-1	TWO WAY/ TWO POSITION	25.4	<1
V-2	C-2	TWO WAY/ TWO POSITION	25.4	<1
V-3	C-3	TWO WAY/ TWO POSITION	25.4	<1
V-4	WSHP-1	THREE WAY/ TWO POSITION	70	<1
V-5	NON-POTABLE	THREE WAY/ TWO POSITION	70	<1
V-6	NON-POTABLE	THREE WAY/ TWO POSITION	70	<1
V-7	GREENHOUSE HEATING	THREE WAY/ MODULATING	15	3-5
V-8	VENTILATION COOLING	THREE WAY/ MODULATING	15	3-5
V-9	NON-POTABLE	TWO WAY/ MODULATING	70	3-5

EXISTING ROOF HOOD SCHEDULE (RH)

PLAN CODE	AREA/ FUNCTION	CFM (ALT.)	PRESSURE DROP (IN WC.)	THROAT SIZE		MAX. OVERALL SIZE			MAX. WEIGHT (LBS)	MANUFACTURER & MODEL NO.	REMARKS
				L	W	L	W	H			
RH-1 RH-2	OSA INTAKE EXHAUST AIR ERV-1	2500	0.017	36	16	51	39	16	126	COOK 16x36 GI	-

EXISTING STORAGE SCHEDULE (ST)

PLAN CODE	VOLUME (GALLONS)	DIMENSIONS		CONNECTION SIZES				MANUFACTURER & MODEL NO.	REMARKS
		DIAMETER (IN.)	HEIGHT (IN.)	WATER IN (IN.)	WATER OUT (IN.)	CIRCULATION IN (IN.)	CIRCULATION OUT (IN.)		
ST-1	40	24	33	1-1/2"	1-1/2"	1-1/2"	1-1/2"	A.O. SMITH DEL-40	PROVIDE WITH GLASS LINING. INSULATION TO BE NO LESS THAN R-12.5.

EXISTING EXPANSION TANK SCHEDULE (ET)

PLAN CODE	SYSTEM SERVED	WATER TEMP. (°F)	% GLYCOL	TANK VOL. (GAL)	ACCEPTANCE VAL. (GAL)	PRE-CHARGE (PSI)	MAX. DIMENSIONS			MANUFACTURER & MODEL NO.	REMARKS
							DIA. (IN.)	H (IN.)	OPERATING WT. (LBS)		
ET-1	WSHP-1	240	30%	11	11	125	12	27	135	WESSELS NLAP40	-
ET-2	SOLAR FLUID	240	30%	11	11	125	12	27	135	WESSELS NLAP40	-
ET-3	CONDENSER WATER	120	-	11	11	12	12	27	135	WESSELS NLAP40	-

EXISTING WATER FILTER SCHEDULE (WF)

PLAN CODE	FLOW RATE (GPM)	P.D. (FT.)	FILTRATION EFF.	TYPE	OPERATING WEIGHT (LB)	DIMENSIONS		MANUFACTURER & MODEL NO.	REMARKS
						DIAMETER (IN.)	HEIGHT (IN.)		
WF-1	350	12	89% @ 754 MICRON	CENTRIFUGAL SEPARATOR	1000	18	78	LAKOS HTX-0285	PROVIDE WITH SOLIDS RECOVERY VESSEL

EXISTING AIR COOLED CONDENSING UNIT SCHEDULE (ACU)

PLAN CODE	AREA SERVED	SEER	NET COOLING MBH	ELECTRICAL			MAX. DIMENSIONS				MANUFACTURER & MODEL NO.	REMARKS
				VOLTAGE & PHASE	MCA	MOCP	LENGTH (IN.)	WIDTH (IN.)	HEIGHT (IN.)	OPERATING WT. (LBS)		
ACU-1	DATA	13	27	208/1	11	20	37	15	28	190	CARRIER 38HDF030	WITH LOW AMBIENT KIT
ACU-2	ELECTRICAL	13	27	208/1	11	20	37	15	28	190	CARRIER 38HDF030	WITH LOW AMBIENT KIT

EXISTING DX FAN COIL UNIT SCHEDULE (DXFC)

PLAN CODE	AREA SERVED	CFM (ALT.)	CAPACITY		AIR SIDE		REFRIGERANT TYPE	MAX. DIMENSIONS				BLOWER WATTS	ELECT. VOLT / PHASE	FLA	MANUFACTURER & MODEL NO.	REMARKS
			SENS. MBH	TOTAL MBH	EAT (°F) db	LAT (°F) db		LENGTH (IN)	WIDTH (IN)	HEIGHT (IN)	OPERATING WT. (LBS)					
DXFC-1	DATA	645	14	27	75	55	410-A	43	8	12	31	31	208/1	.26	CARRIER 40QNQ03	-
DXFC-2	ELECTRICAL	645	14	27	75	55	410-A	43	8	12	31	31	208/1	.26	CARRIER 40QNQ03	-

EXISTING CHILLED WATER COIL (CC)

PLAN CODE	CFM@ ELEC. ea.	MAS. F.V. (FPM)	CAPACITY MBH		AIR SIDE			5454					ROWS	FINS/ INCH	MAX. SIZE		REMARKS
			SENS. MBH	TOTAL MBH	EAT °F DB/WB	LAT °F DB/WB	MAX AIR PRESS. DROP	EWT (°F)	LWT (°F)	TOTAL GPM	% GLYCOL	MAX. PRESS. DROP (FT. HD.)			W	H	
CC-1	1340	400	39.3	39.3	80/56	54/45	0.3	45	55	8.2	30	4	2	8	18	28	PROVIDE WITH COIL ENCLOSURE AND DRAIN PAN.
CC-2	1115	400	32.6	32.6	80/56	54/45	0.3	45	55	8.2	30	4	2	8	18	28	PROVIDE WITH COIL ENCLOSURE AND DRAIN PAN.

EXISTING VARIABLE FREQUENCY DRIVE SCHEDULE (VFD)

PLAN CODE	SERVICE	DRIVE TYPE	BYPASS	ALTITUDE (FT)	MAX AMBIENT TEMPERATURE (°F)	CONTROL OF VFD			CONTROL SYS. INTERFACE	HARMONICS ISOLATION	MANUFACTURER & MODEL NO.	REMARKS
						METHOD	MAXIMUM RESPONSE TIME	CONTROLLER INLET				
VFD-1	EXHAUST FAN SUPPLY FAN ERV-1	PULSE WIDTH MODULATION	NONE	4,400	105	ACT	<150 MILLISECONDS	DUCT STATIC	BACNET	INLET REACTORS	ABB ACH550	KEYPAD, LOCKING DISCONNECT
VFD-2	PUMP P-1	PULSE WIDTH MODULATION	NONE	4,400	105	ACT	<150 MILLISECONDS	DIFFERENTIAL PRESSURE	BACNET	INLET REACTORS	ABB ACH550	KEYPAD, LOCKING DISCONNECT
VFD-3	PUMP P-2	PULSE WIDTH MODULATION	NONE	4,400	105	ACT	<150 MILLISECONDS	DIFFERENTIAL PRESSURE	BACNET	INLET REACTORS	ABB ACH550	KEYPAD, LOCKING DISCONNECT

HEATH
Engineering Company

STAMP

LICENSED PROFESSIONAL ENGINEER
No. 270896
ROBERT JACK KESLER
5/9/23
STATE OF UTAH

REVISIONS:

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SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

HEATH PROJECT No:	22099
CHECKED BY:	RJK
DRAWN BY:	KGM
DATE:	November 14, 2023

SHEET DESCRIPTION

EDUCATION CENTER

MECHANICAL SCHEDULES

SHEET NUMBER

M-002

CONSTRUCTION DOCUMENTS

(E)PACKAGED AIR HANDLING UNIT

(E)AIR HANDLING UNIT (AHU-9550)

SYMBOL	AIR HANDLING UNIT SIZE L x W x H	DUTY	MINIMUM OUTSIDE AIR CFM	TOTAL AHU MAXIMUM OPERATING WEIGHT (LB)	REMARKS
AHU-9550	166.38" x 107.62" x 93.62"	MCC AND VFD ROOMS	N.A.	7230	-

HAAKON INDUSTRIES

(E)SUPPLY AIR FAN (SF-9550)

SYMBOL	ORIGINAL AIR FLOW CFM	TOTAL STATIC PRESSURE IN. WC	OUTLET VELOCITY FPM	QUANTITY OF FANS	FAN RPM	BHP	ELECTRICAL					FAN TYPE	FAN WHEEL SIZE	CLASS	DUTY	UNIT SYMBOL	REMARKS
							VOLTS	HERTZ	PHASE	HP	RPM						
SF-9550	24,400	3"	2553	1	1270	N.A.	460	60	3	20	1750	CENTRIFUGAL	30"	II	SUPPLY	AHU-9550	RE-BALANCE SUPPLY FAN, REPLACE SHEAVES AS NEEDED TO LOWER TOTAL CFM TO 13,000 +/-

(E)FILTER SECTION (FS-9550)

SYMBOL	ORIGINAL AIR FLOW CFM	FILTER THICKNESS	FILTER MODEL	FILTER CONFIGURATION	MAX FACE VELOCITY FPM	HOLDING FRAME ARRANGEMENT	REMARKS
FS-9550	24,400	2"	FARR 30-30	24 - 24" x 24"	254	VEE	-

(E)RETURN AIR DAMPER (RAD-9550)

SYMBOL	APPROX. SIZE	TYPE	RUSKIN MODEL	DUTY	REMARKS
RAD-9550	94" x 30"	OPPOSED BLADE	CD-50	AH-9550	-

DX COOLING COIL (CC-9550)

SYMBOL	SENSIBLE CAPACITY MBTUH	TOTAL CFM	ENTERING DB / WB °F	LEAVING DB / WB °F	MAX. AIR PD (IN.)	FACE VELOCITY (FPM)	COIL PER SECTION	NUMBER OF SECTIONS	MIN. ROWS	MAX FINS PER FOOT	NOMINAL COIL SIZE	SUCTION TEMP °F	REMARKS
CC-9550	306	13,000 CFM	80 / 67	55 / 53.3	.183	284	2	1	4	118	2 - 36"H x 91"L	45	1, 2

NOTES:
1. VERIFY EXACT SIZE OF COIL REQUIRED TO FIT IN UNIT BEFORE ORDERING. 2. STANDARD CIRCUITING

SEE SPECIFICATION 237500

CONDENSING UNIT

SYMBOL	NOMINAL COOLING CAPACITY (TONS)	SUCTION TEMP °F	COOLING CIRCUITS	ELECTRICAL CHARACTERISTICS			REF.	E.A.T. CONDENS. °F	MAX. UNIT SIZE H x W x L	MCA AMPS	MOP AMPS	E.E.R.	TRANE MODEL	REMARKS
				VOLTS	HERTZ	PHASE								
CU-1	25	45	2	460	60	3	R410A	97	74-1/4" x 60-1/8" x 88-5/16"	52	70	12.1	RAUC25	-

SEE SPECIFICATION 232300

PACKAGED AIR HANDLING UNIT

AIR HANDLING UNIT (AHU-9510)

SYMBOL	AIR HANDLING UNIT SIZE L x W x H	DUTY	MINIMUM OUTSIDE AIR CFM	TOTAL AHU MAXIMUM OPERATING WEIGHT (LB)	REMARKS
AHU-9510	79" x 76.125" x 92.875"	RO BUILDING OFFICE AREA	900	1530	-

SELECTION BASED ON TRANE
SEE SPECIFICATION SECTION 237300

SUPPLY AIR FAN (SF-9510)

SYMBOL	NOMINAL COOLING AIR FLOW CFM	TOTAL STATIC PRESSURE IN. WC	OUTLET VELOCITY FPM	HEATING AIR FLOW CFM	QUANTITY OF FANS	FAN RPM	BHP	ELECTRICAL					FAN TYPE	FAN WHEEL SIZE	CLASS	DUTY	UNIT SYMBOL	VFD NUMBER	REMARKS
								VOLTS	HERTZ	PHASE	HP	RPM							
SF-9510	8,785	3.343"	2507	3,130	1	1081	7.7	460	60	3	10	VARIES	CENTRIFUGAL	N.A.	N.A.	SUPPLY	AHU-9510	VFD-1	-

DX COOLING COIL (CC-9510)

SYMBOL	SENSIBLE COOLING CAPACITY MBTUH	TOTAL COOLING CFM	ENTERING DB / WB °F	LEAVING DB / WB °F	MAX. AIR PD (IN.)	FACE VELOCITY (FPM)	MIN. HEAT CAPACITY MBTUH AT 0°F	COIL PER SECTION	NUMBER OF SECTIONS	MIN. ROWS	MAX FINS PER FOOT	NOMINAL COIL SIZE (SQ. FT.)	SUCTION TEMP °F	REMARKS
CC-9510	223.45	8,785	80 / 62	54.07 / 52.61	.736	539	100	1	1	6	12	16.3	45	INTERTWINED CIRCUIT WITH 2 DX 1/4" DISTRIBUTORS

FILTER SECTION (FS-9510)

SYMBOL	MINIMUM AIR FLOW CFM	FILTER TYPE / THICKNESS	FILTER CONFIGURATION	MAX FACE VELOCITY FPM	HOLDING FRAME ARRANGEMENT	REMARKS
FS-9510	8,785	2" MERV 8	6 - 16" x 20", 6 - 20" x 20"	293	VEE	-

RETURN AIR DAMPER (RAD-9510)

SYMBOL	APPROX. SIZE	TYPE	RUSKIN MODEL	DUTY	REMARKS
RAD-9510	54" x 23"	PARALLEL	CD-50	RETURN AIR	-

OUTSIDE AIR DAMPER (OAD-9510)

SYMBOL	APPROX. SIZE	TYPE	RUSKIN MODEL	DUTY	REMARKS
OAD-9510	54" x 23"	PARALLEL	CD-50	OUTSIDE AIR	-

SEE SPECIFICATION 237300

HEATH
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SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	RJK
DRAWN BY:	KGM
DATE:	November 14, 2023

SHEET DESCRIPTION

SWGWTP

MECHANICAL SCHEDULES

SHEET NUMBER

M-003

HEAT PUMP (HP) (LOCATED IN RO BUILDING)

SYMBOL	COOLING CAPACITY MBH	SUCTION TEMP. °F	COOLING STAGES	ELECTRICAL CHARACTERISTICS			REF.	E.A.T. CONDENS. °F	MAX. UNIT SIZE H x W x L	MCA AMPS	MOCP AMPS	E.E.R.	TRANE MODEL	REMARKS
				VOLTS	HERTZ	PHASE								
HP-5	240	45	2	460	60	3	R410A	VARIES FROM 0 - 97	45-1/8" x 46" x 93-5/16"	40	50	VARIES	TWA24044DAA	-

SEE SPECIFICATION 232300

AIRFLOW MEASUREMENT STATION (AFM)

SYMBOL	DUTY	LOCATION	DUCTWORK APPROX. SIZE INSIDE CLEAR	EBTRON MODEL	ELECTRICAL			REMARKS
					VOLTS	HERTZ	PHASE	
AFM-100	AHU-9510	O.A. DUCT TO AHU-9510	54"x24"	GOLD	24	60	1	VERIFY EXACT SIZE REQUIRED TO MATCH THE SIZE OF THE OUTSIDE AIR DUCT THE AIRFLOW STATION WILL BE INSERTED INTO BEFORE ORDERING.

SEE SPECIFICATION 230516

ELECTRIC HEATING COIL (EHC)

SYMBOL	COOLING AIR FLOW CFM	MAX PRESS. DROP INCHES WC (BASED ON CLG. CFM)	HEATING AIR FLOW CFM	HEATING ENTERING AIR TEMP. °F	HEATING LEAVING AIR TEMP. °F	MAX FACE VELOCITY FPM COOLING	MAX FACE VELOCITY FPM HEATING	KW	ELECTRICAL CHARACTERISTICS			MANUFACTURER	TYPE	NOMINAL SIZE	REMARKS
									VOLTS	HERTZ	PHASE				
EHC-1	8,785	0.25	3,130	66	84	2,196	782	15	460	60	3	INDEECO	QUZ OPEN COIL	24" x 24"	PROVIDE WITH RIGHT-HANDED ACCESS PANEL WITH AIR BLOWING TOWARD YOUR BACK.

SELECTION BASED ON INDEECO
SEE SPECIFICATION 238241

LOUVER (L)

SYMBOL	CFM	MAX DIR PRESS. DROP INCHES WC	NOMINAL SIZE	MINIMUM SQ. FT.	MAX FACE VELOCITY	DUTY	RUSKIN MODEL	LOCATION	REMARKS
L-1	8,785	0.10	48" x48"	16	549	AHU-9510 OUTSIDE AIR	CD-50	PALLET STORAGE 216	-

SELECTION BASED ON RUSKIN
SEE SPECIFICATION 233713

MOTORIZED DAMPER (MD)

SYMBOL	SIZE	TOTAL AREA (SQ. FT.)	BLADE ORIENTATION	RUSKIN MODEL	NOMINAL POSITION	SERVICE	LOCATION	REMARKS
MD-1	36" x 24"	6	OPPOSED	CD-50	N.C.	AHU-9510 RELIEF AIR	HVAC ROOM 215	-

SEE SPECIFICATION 233300

GRILLE AND DIFFUSER SCHEDULE

SYMBOL	FACE PANEL SIZE	TYPE	MODEL	REMARKS
R-1	SEE DWGS	PERFORATED	KRUEGER	EXACT STYLE TO MATCH EXISTING DUCT MOUNTED RA GRILLES IN THE VFD ROOM. FIELD VERIFY.

SELECTION BASED ON KRUEGER
SEE SPECIFICATION 233713

HEATH Engineering Company

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LICENSED PROFESSIONAL ENGINEER
No. 270896
ROBERT JACK KESLER
STATE OF UTAH

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SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	RJK
DRAWN BY:	KGM
DATE:	November 14, 2023

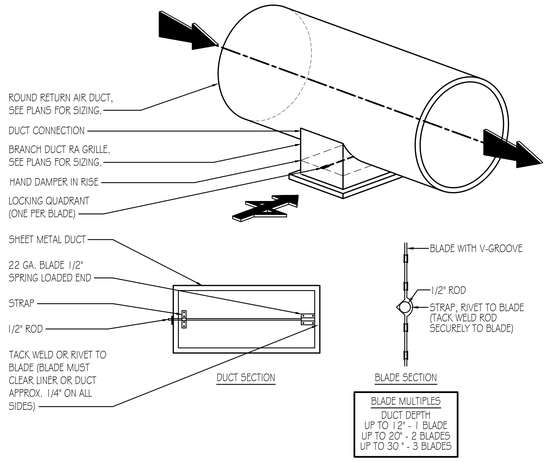
SHEET DESCRIPTION

SWGWTP

MECHANICAL
SCHEDULES

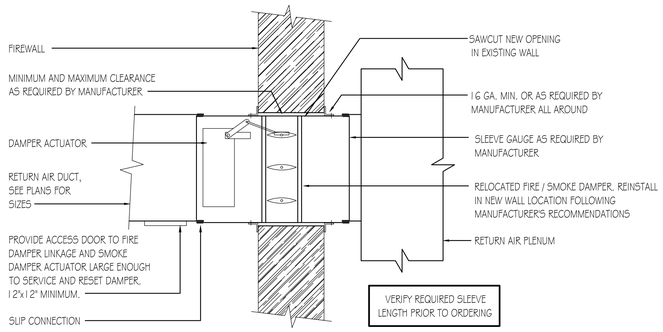
SHEET NUMBER

M-004



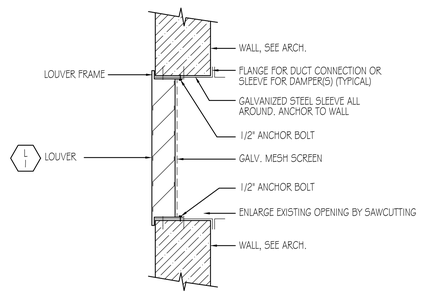
6 M-501 RA TAKEOFF AND DAMPER DETAIL

SCALE: NONE



7 M-501 FIRE / SMOKE DAMPER (F.S.D.) DETAIL

SCALE: NONE



8 M-501 LOUVER DETAIL

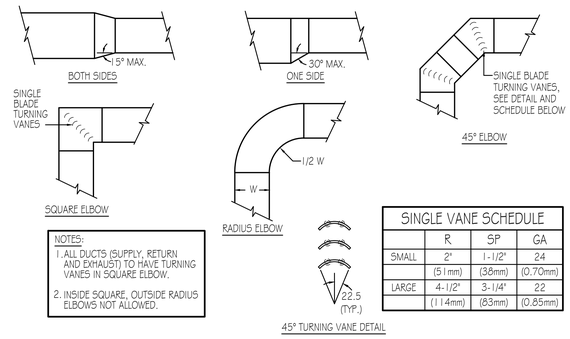
SCALE: NONE

DIMENSION OF LONGEST SIDE, (INCHES)	SHEET METAL GAGE (ALL FOUR SIDES)	* TRANSVERSE REINFORCING										
		MINIMUM REINFORCING ANGLE SIZE AND MAXIMUM LONGITUDINAL SPACING BETWEEN TRANSVERSE JOINTS AND / OR INTERMEDIATE REINFORCING	AT JOINTS									
			MIN H	DRIVE SLIP / PLAIN S SLIP		HEMMED S SLIP	ALT. BAR SLIP	REIN-FORCED BAR SLIP	BAR SLIP / ANGLE SLIP		STD. SEAM / ANGLE REINFORCED STD. SEAM	POCKET LOCK / ANGLE REINFORCED POCKET LOCK
				RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	RECOM-MENDED GAGE	REINFORCED ANGLE SIZE	REINFORCED ANGLE SIZE	RECOM-MENDED GAGE	REINFORCED ANGLE SIZE
UP THRU 12	24	NONE REQUIRED	1"	26	26	24	24	24	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	24	NOT REQUIRED
13-18	24	NONE REQUIRED	1"	24	24	24	24	24	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	24	NOT REQUIRED
19-30	24	1 x 1 x 1/8 @60"	1"	-	24	24	24	24	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	24	NOT REQUIRED
31-42	22	1 x 1 x 1/8 @60"	1"	-	-	22	22	22	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	22	NOT REQUIRED
43-54	22	1-1/2 x 1-1/2 x 1/8 @60"	1-1/2"	-	-	22	22	22	1-1/2 x 1-1/2 x 1/8	NOT REQUIRED	NOT REQUIRED	22	NOT REQUIRED
55-60	20	1-1/2 x 1-1/2 x 1/8 @60"	1-1/2"	-	-	-	22	22	1-1/2 x 1-1/2 x 1/8	NOT REQUIRED	NOT REQUIRED	22	NOT REQUIRED
61-84	20	1-1/2 x 1-1/2 x 1/8 @60"	1-1/2"	-	-	-	-	22	1-1/2 x 1-1/2 x 1/8	1-1/2 x 1-1/2 x 1/8	1-1/2 x 1-1/2 x 1/8	22	1-1/2 x 1-1/2 x 1/8

* TRANSVERSE REINFORCING SIZE IS DETERMINED BY DIMENSION OF SIDE TO WHICH ANGLE IS APPLIED.

1 M-501 DUCT CONSTRUCTION DETAIL

SCALE: NONE



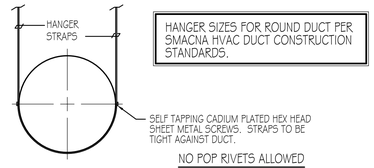
NOTES:
1. ALL DUCTS (SUPPLY, RETURN AND EXHAUST) TO HAVE TURNING VANES IN SQUARE ELBOW.
2. INSIDE SQUARE, OUTSIDE RADIUS ELBOWS NOT ALLOWED.

SINGLE VANE SCHEDULE

	R	SP	GA
SMALL	2" (51mm)	1-1/2" (38mm)	24 (0.70mm)
LARGE	4-1/2" (114mm)	3-1/4" (83mm)	22 (0.85mm)

2 M-501 RECTANGULAR DUCT FITTINGS DETAIL

SCALE: NONE

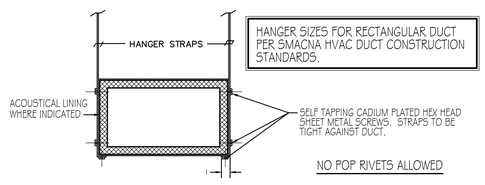


HANGER SIZES FOR ROUND DUCT PER SMACNA HVAC DUCT CONSTRUCTION STANDARDS.

NO POP RIVETS ALLOWED

3 M-501 ROUND DUCT HANGER DETAIL

SCALE: NONE

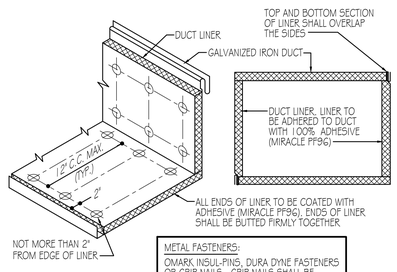


HANGER SIZES FOR RECTANGULAR DUCT PER SMACNA HVAC DUCT CONSTRUCTION STANDARDS.

NO POP RIVETS ALLOWED

4 M-501 DUCT STRAP HANGER DETAIL

SCALE: NONE



METAL FASTENERS:
OMARK INSUL-PINS, DURA DYNE FASTENERS OR GRIP NAILS. GRIP NAILS SHALL BE INSTALLED BY "GRIP NAIL AIR HAMMER" OR BY "AUTOMATIC FASTENER EQUIPMENT".

5 M-501 DUCT LINER DETAIL

SCALE: NONE

HEATH Engineering Company

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No. 270896
ROBERT JACK KESLER
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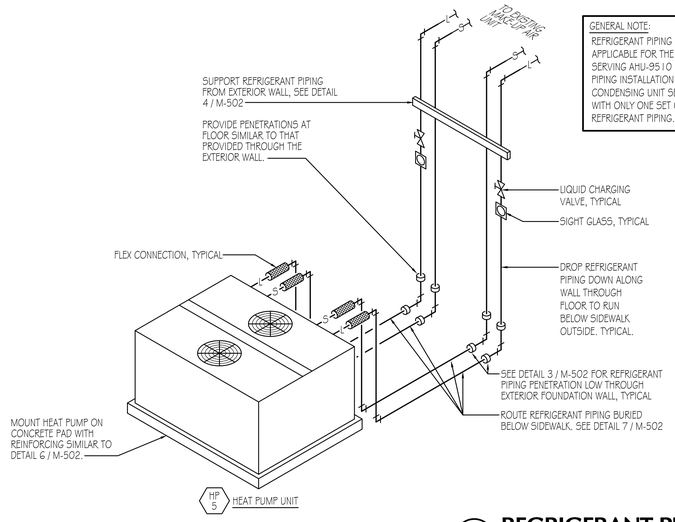
SHEET DESCRIPTION

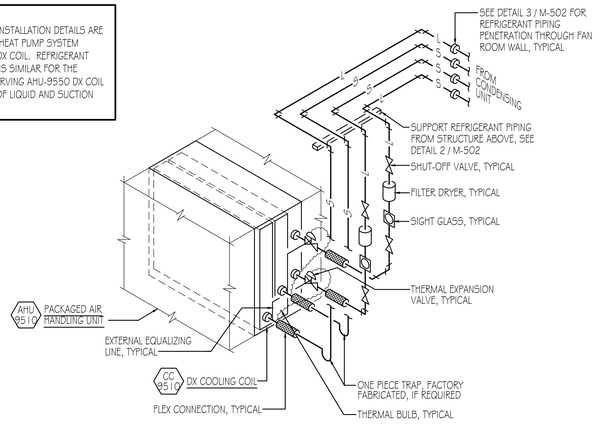
MECHANICAL DUCTWORK DETAILS

SHEET NUMBER

M-501

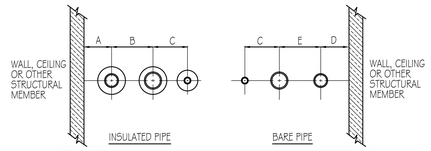


GENERAL NOTE:
REFRIGERANT PIPING INSTALLATION DETAILS ARE APPLICABLE FOR THE HEAT PUMP SYSTEM SERVING AHU-9510 DX COIL. REFRIGERANT PIPING INSTALLATION IS SIMILAR FOR THE CONDENSING UNIT SERVING AHU-9550 DX COIL WITH ONLY ONE SET OF LIQUID AND SUCTION REFRIGERANT PIPING.



5 M-502 REGRIGERANT PIPING SCHEMATIC

SCALE: NONE

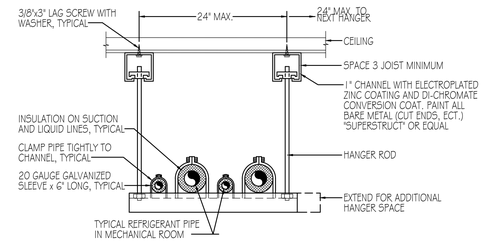


MINIMUM CENTERLINE SPACING				
NOMINAL PIPE SIZE	DIMENSION A	DIMENSION B	DIMENSION C	DIMENSION D
1/2", 3/4"	5"	6"	3-1/2"	3"
1", 1-1/4", 1-1/2"	6"	8"	4"	4"
2", 2-1/2"	7"	10"	4-1/2"	5"
3", 3-1/2"	7-1/2"	11"	5"	6"
4"	8"	12"	5-1/2"	7"
5"	8-1/2"	13"	6"	8"
6"	9"	14"	6-1/2"	9"
8"	10"	16"	7-1/2"	11"

NOTES:
1. DIM "C": WHERE PIPES OF DIFFERENT SIZE ARE RUN PARALLEL, USE ONE-HALF OF THE DIMENSION TABULATED FOR THE LARGER PIPE, PLUS ONE-HALF OF THE DIMENSION TABULATED FOR THE SMALLER PIPE, TO DETERMINE THE MIN. CENTER LINE SPACING BETWEEN ADJACENT RUNS.
2. TABLE APPLIES ONLY TO PIPING RUNS WHICH ARE NOT DIMENSIONED ON THE PIPING PLANS.

1 M-502 PIPE CLEARANCE DETAIL

SCALE: NONE

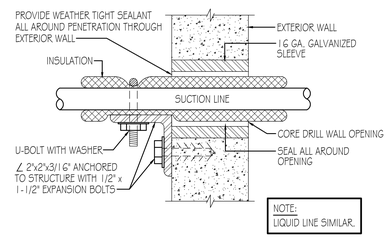


PIPE SIZE	MAXIMUM SPACING	PIPE LOAD WEIGHT / FT. TOTAL	ROD SIZE
1" AND SMALLER	8	2.5 / 20	3/8"
1-1/4" - 2"	10	6 / 60	3/8"

NOTE:
HANGERS SIZES AND SPACING ARE FOR SINGLE PIPES. HANGER ROD LOADING FOR TRAPEZE HANGERS SHALL NOT EXCEED THE TOTAL LOADING INDICATED. IF SMALLER ROD SIZE IS USED, DECREASE MAXIMUN SPACING SO THAT TOTAL LOADING IS NOT EXCEEDED. SUPPORT FROM STRUCTURE PANEL POINTS.

2 M-502 REFRIGERANT PIPE HANGER DETAIL

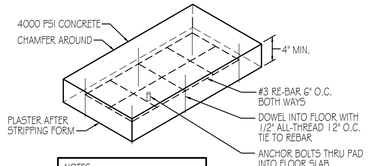
SCALE: NONE



NOTE:
LIQUID LINE SIMILAR.

3 M-502 REFRIGERANT PIPE ANCHOR AT WALL DETAIL

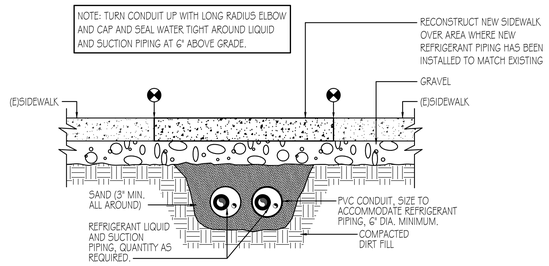
SCALE: NONE — SIMILAR METHOD FOR ROUTING THROUGH CONCRETE FLOOR



NOTES:
1. OVERALL SIZE AS REQUIRED BY EQUIPMENT, 12"x12" MINIMUM.
2. USE SPECIAL BASES WHERE CALLED FOR.

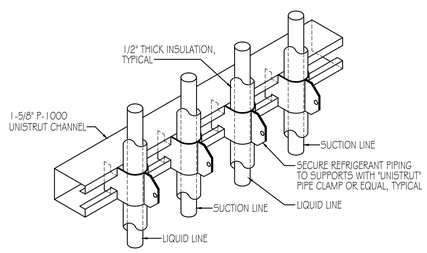
6 M-502 CONCRETE BASE / HOUSEKEEPING PAD DETAIL

SCALE: NONE



7 M-502 UNDERGROUND REFRIGERANT PIPING DETAIL

SCALE: NONE



4 M-502 REFRIGERANT PIPE VERTICAL SUPPORT MOUNTED TO WALL DETAIL

SCALE: NONE

HEATH Engineering Company

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LICENSED PROFESSIONAL ENGINEER
No. 270896
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STATE OF UTAH

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DRAWN BY:	KGM
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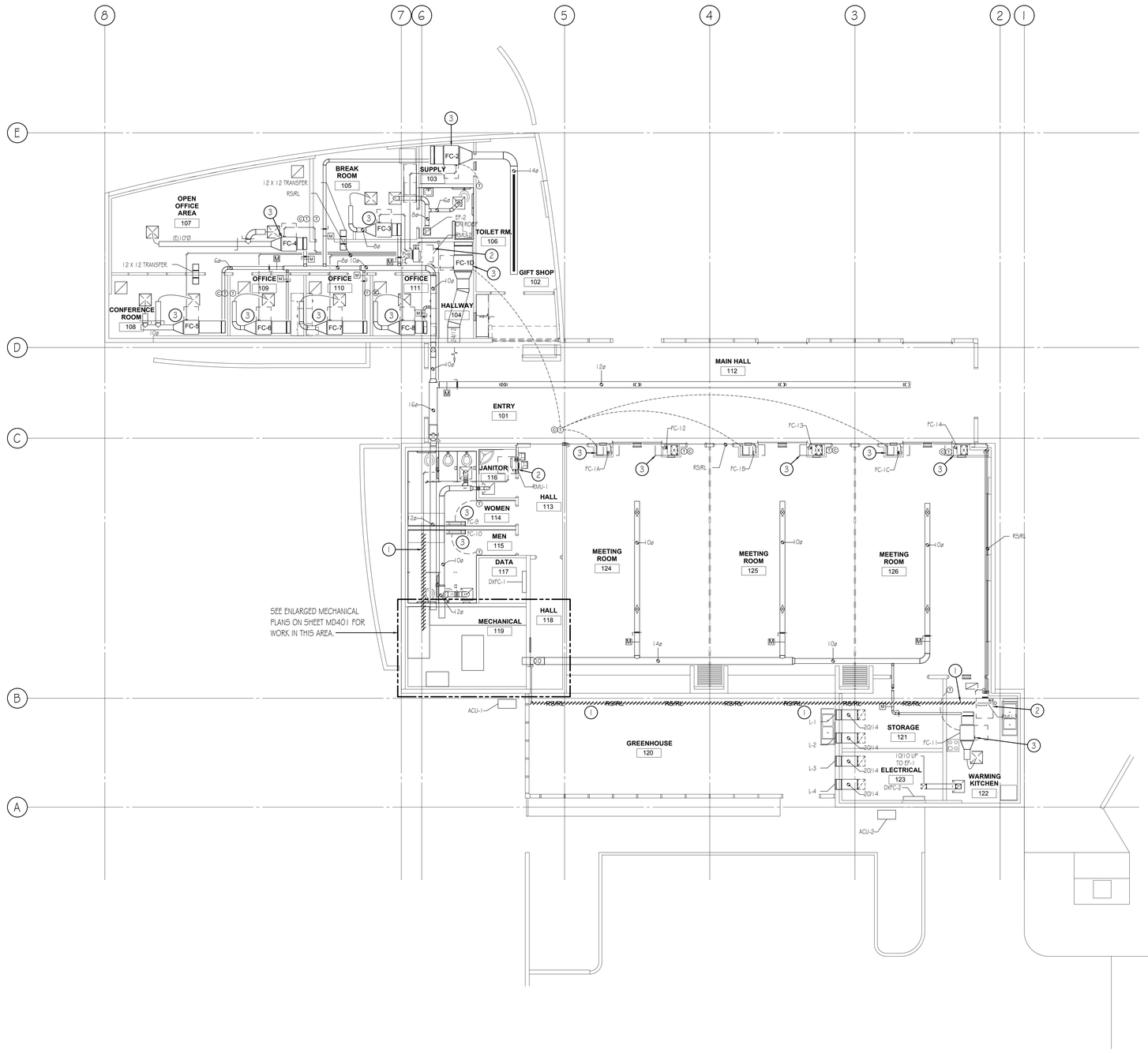
CONSTRUCTION DOCUMENTS

SHEET DESCRIPTION
MECHANICAL PIPING DETAILS

SHEET NUMBER
M-502

DRAWING NOTES

1. REMOVE EXISTING REFRIGERANT LIQUID AND SUCTION LINES AS REQUIRED PREPARATORY FOR NEW ROUTING TO NEW HEAT PUMP UNITS. SEE REMODEL PLAN.
2. EXISTING REFRIGERANT MANAGEMENT UNIT TO REMAIN. PROTECT DURING CONSTRUCTION.
3. EXISTING FAN COIL UNIT TO REMAIN. PROTECT DURING CONSTRUCTION.



1 MD101 **EDUCATION CENTER MECHANICAL DEMOLITION PLAN**
SCALE: 1/8"=1'-0"
10 5 0 10 20

HEATH
Engineering Company

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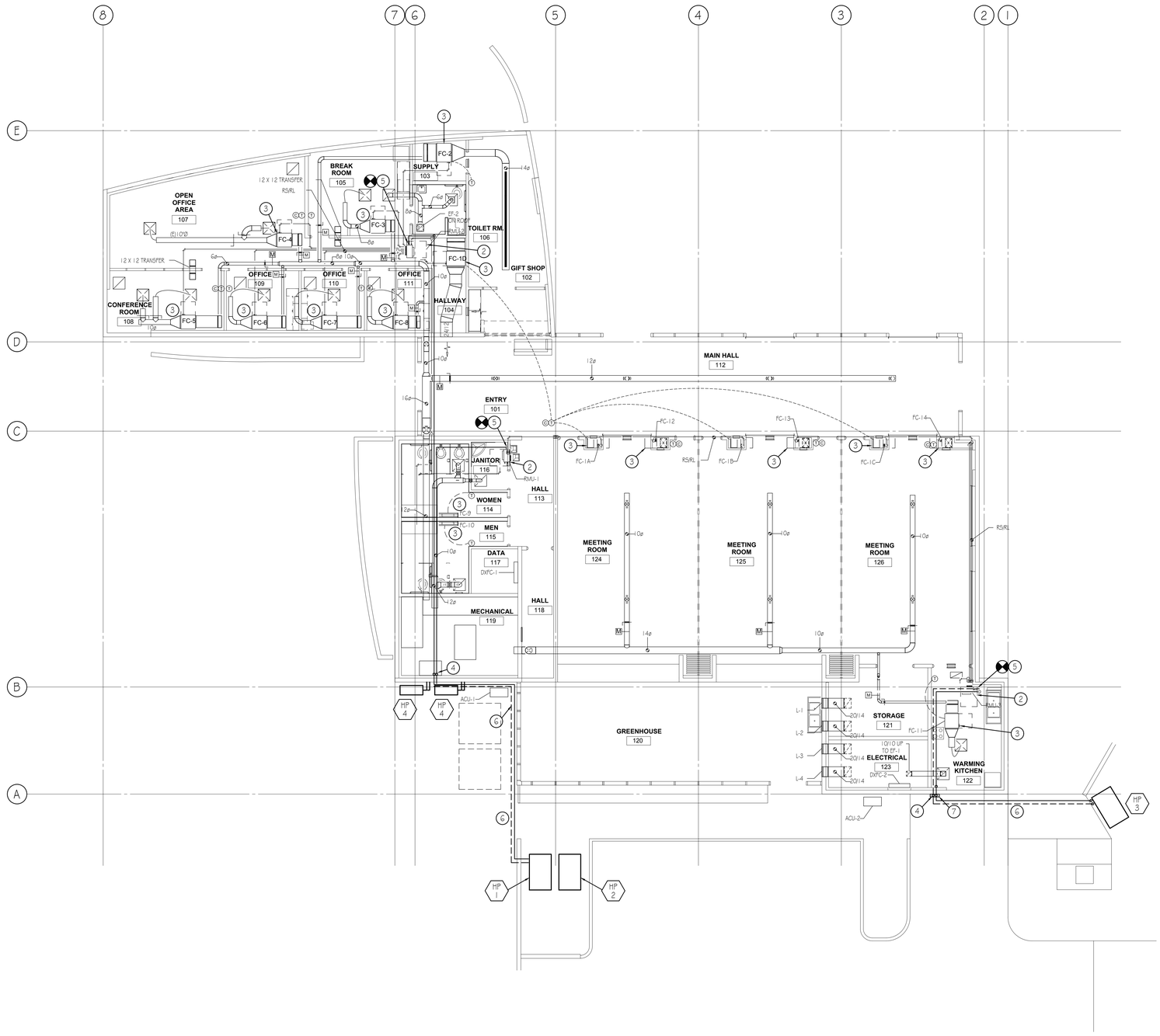
MECHANICAL DEMOLITION PLAN

SHEET NUMBER

MD101



EDUCATION CENTER MECHANICAL REMODEL PLAN

1 / M-2 SCALE: 1/8"= 1'-0"

10 5 0 10 20

DRAWING NOTES

1. REMOVE EXISTING REFRIGERANT LIQUID AND SUCTION LINES AS REQUIRED PREPARATORY FOR NEW ROUTING TO NEW HEAT PUMP UNITS. SEE REMODEL PLAN.
2. EXISTING REFRIGERANT MANAGEMENT UNIT TO REMAIN. PROTECT DURING CONSTRUCTION.
3. EXISTING FAN COIL UNIT TO REMAIN. PROTECT DURING CONSTRUCTION.
4. RISE NEW REFRIGERANT LIQUID AND SUCTION LINE(S) ON WALL AND ROUTE AS SHOWN AS HIGH AS POSSIBLE.
5. CONNECT NEW REFRIGERANT LIQUID AND SUCTION LINES TO EXISTING REFRIGERANT MANAGEMENT UNIT. FOLLOW MANUFACTURER'S WRITTEN INSTRUCTIONS FOR CHARGING THE SYSTEM REFRIGERANT.
6. ROUTE NEW REFRIGERANT LIQUID AND SUCTION LINES IN CONDUIT BELOW EXISTING CONCRETE SLAB, SEE DETAIL 7 / M-502 FOR INSTALLATION REQUIREMENTS AND CONCRETE PATCHING.
7. PROVIDE STAINLESS STEEL COVER OVER REFRIGERANT PIPING FROM SLAB TO WHERE PIPING TURNS INTO THE CEILING SPACE. COVER SHALL BE SIZED TO COVER PIPING AND HAVE A SLOPED TOP TO SHED RAIN WATER. PROVIDE SEAL BETWEEN COVER AND EXISTING CONCRETE WALL. ATTACH TO WALL WITH ANCHOR BOLTS ON 18" CENTERS.

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EDUCATION CENTER

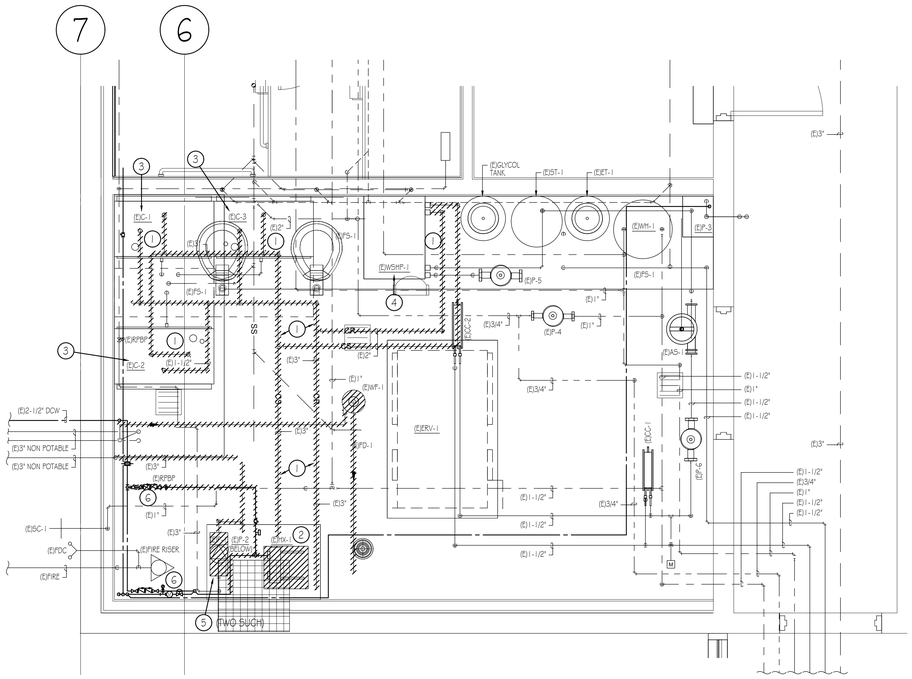
MECHANICAL
REMODEL PLAN

SHEET NUMBER

MH101

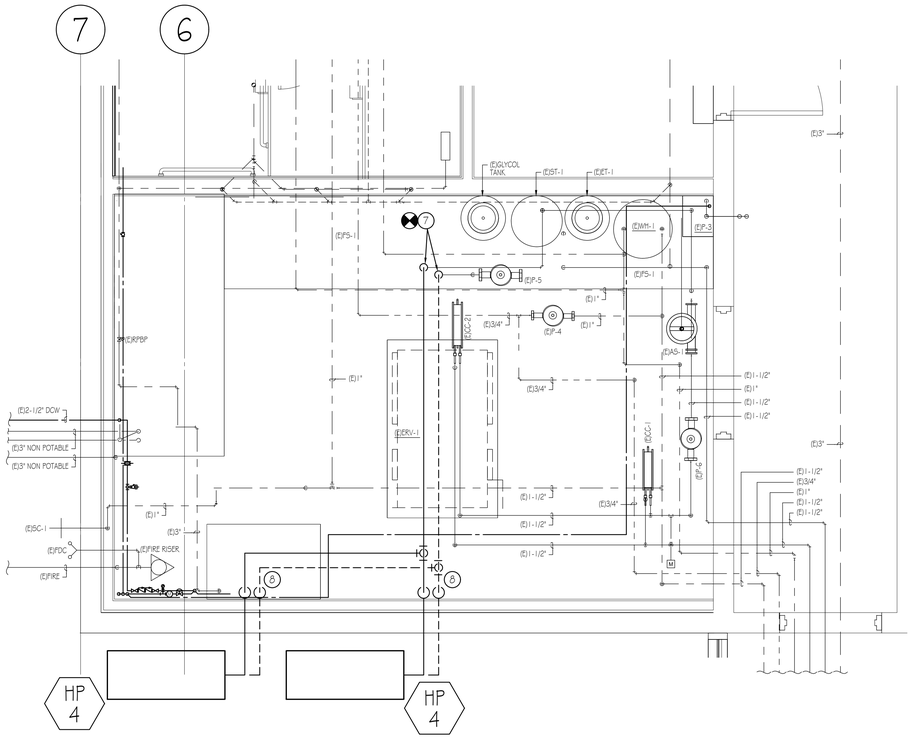
DRAWING NOTES

1. REMOVE EXISTING PLANT WATER SUPPLY AND RETURN PIPING COMPLETE. SEE FLOW DIAGRAM FOR ADDITIONAL DETAIL.
2. REMOVE EXISTING PLATE & FRAME HEAT EXCHANGER COMPLETE.
3. REMOVE EXISTING COMPRESSOR UNIT COMPLETE. FOLLOW MANUFACTURERS WRITTEN INSTRUCTIONS FOR REFRIGERANT EVACUATION.
4. REMOVE EXISTING WATER SOURCE HEAT PUMP UNIT COMPLETE. DISCONNECT HEATING WATER SUPPLY AND RETURN PIPING PREPARATORY FOR NEW CONNECTION.
5. REMOVE EXISTING PLANT WATER CIRCULATING PUMPS COMPLETE.
6. REMOVE DOMESTIC COLD WATER BACK-UP CONNECTIONS. SEE FLOW DIAGRAM FOR ADDITIONAL DETAIL.
7. CONNECT NEW 2" CHILLED WATER SUPPLY AND RETURN PIPING TO EXISTING. FIELD VERIFY EXACT LOCATION.
8. RISE 1-1/4" CHILLED WATER SUPPLY AND RETURN PIPING ON WALL AND ROUTE AS SHOWN.



1 MH401 ENLARGED MECHANICAL DEMOLITION PLAN - EDUCATION CENTER

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



2 MH401 ENLARGED MECHANICAL REMODEL PLAN - EDUCATION CENTER

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

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STAMP

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No. 270896
ROBERT JACK KESLER
STATE OF UTAH

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CONSTRUCTION DOCUMENTS

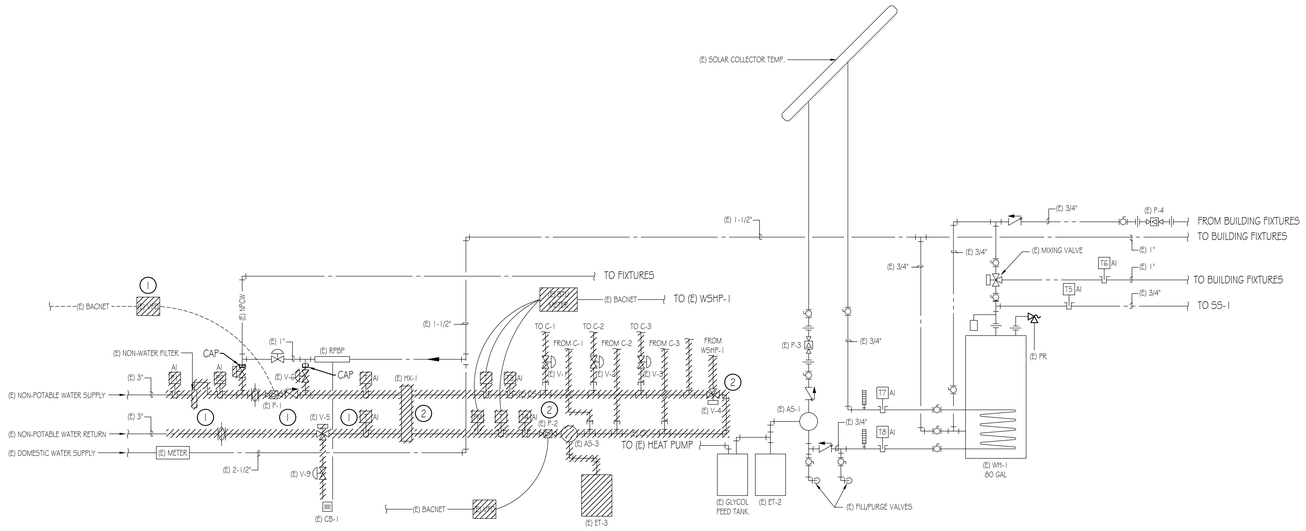
SHEET DESCRIPTION

EDUCATION CENTER

ENLARGED MECHANICAL DEMOLITION AND REMODEL PLANS

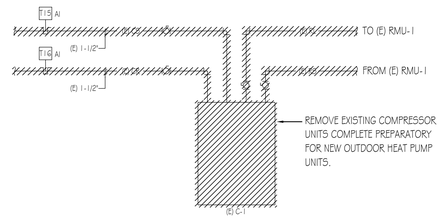
SHEET NUMBER

MH401



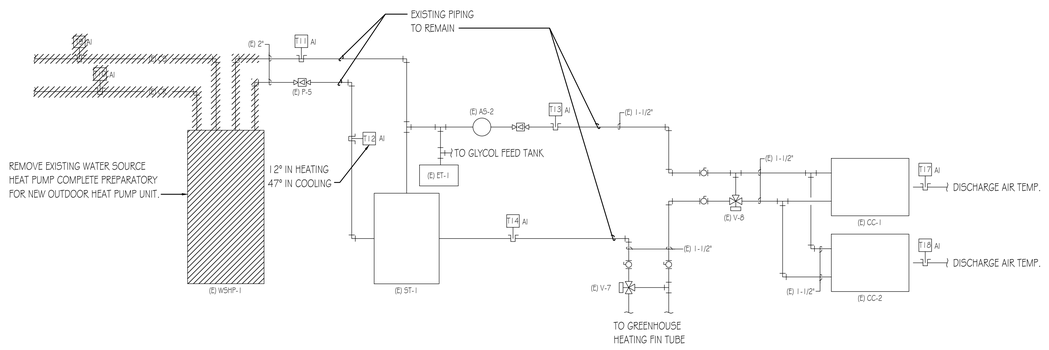
1 MP601 **DOMESTIC WATER SCHEMATIC - DEMOLITION**

SCALE: NONE



2 MP601 **COMPRESSOR UNIT SCHEMATIC (TYP. OF 3) - DEMOLITION**

SCALE: NONE



3 MP601 **WATER TO WATER HEAT PUMP SCHEMATIC - DEMOLITION**

SCALE: NONE

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No. 270896
ROBERT JACK KESLER
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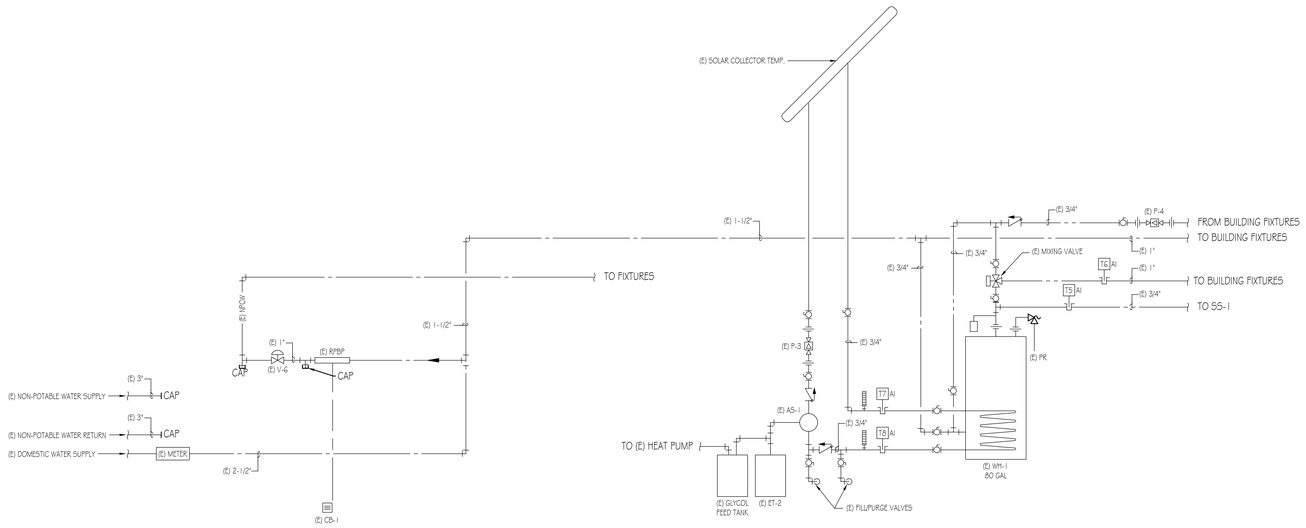
SHEET DESCRIPTION

EDUCATION CENTER

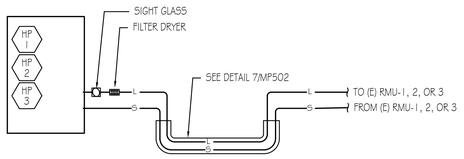
FLOW DIAGRAMS - DEMOLITION

SHEET NUMBER

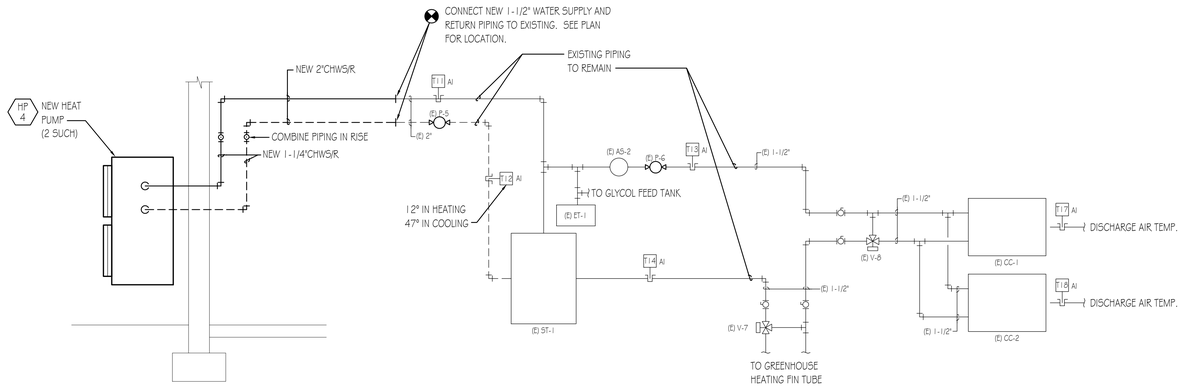
MP601



1 MP602 **DOMESTIC WATER SCHEMATIC - REMODEL**
SCALE: NONE



2 MP602 **HEAT PUMP UNIT SCHEMATIC (TYP. OF 3) - REMODEL**
SCALE: NONE



3 MP602 **AIR TO WATER HEAT PUMP SCHEMATIC - REMODEL**
SCALE: NONE

HEATH
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LICENSED PROFESSIONAL ENGINEER
No. 270896
ROBERT JACK KESLER
STATE OF UTAH

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

HEATH PROJECT No:	22099
CHECKED BY:	RJK
DRAWN BY:	KGM
DATE:	November 14, 2023

CONSTRUCTION DOCUMENTS

SHEET DESCRIPTION

EDUCATION CENTER

FLOW DIAGRAMS - REMODEL

SHEET NUMBER

MP602

SEQUENCE OF OPERATION

- START ERV-1 WHEN BUILDING IS OCCUPIED.

- GENERATE ALARM IN A STATUS DOES NOT MATCH COMMAND.

- MODULATE SUPPLY FAN SPEED TO MAINTAIN SUPPLY DUCT STATIC PRESSURE SET POINT AT 0.1" W.G. (ADJ.).

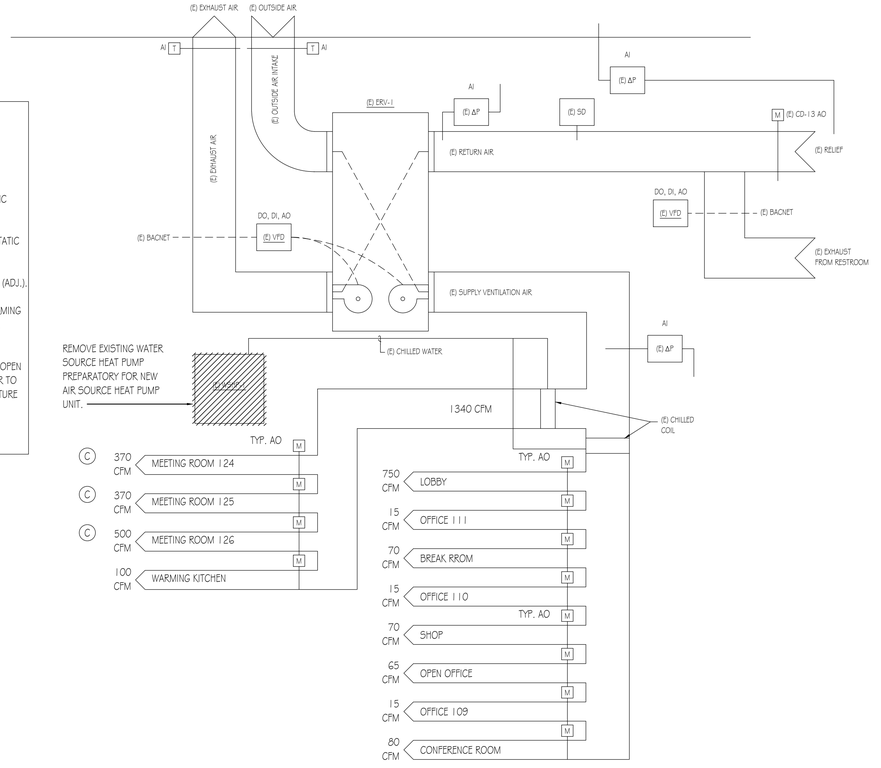
- MODULATE EXHAUST FAN SPEED TO MAINTAIN EXHAUST DUCT STATIC PRESSURE AT 0.1" W.G. (ADJ.)

- MODULATE CD-13 TO MAINTAIN BUILDING STATIC AT 0.05" W.G. (ADJ.).

- MONITOR OCCUPANCY SENSOR IN OFFICES, BREAK ROOM, WARMING KITCHEN, CONFERENCE ROOM, AND GIFT SHOP. OPEN CONTROL DAMPER WHEN ROOM IS OCCUPIED.

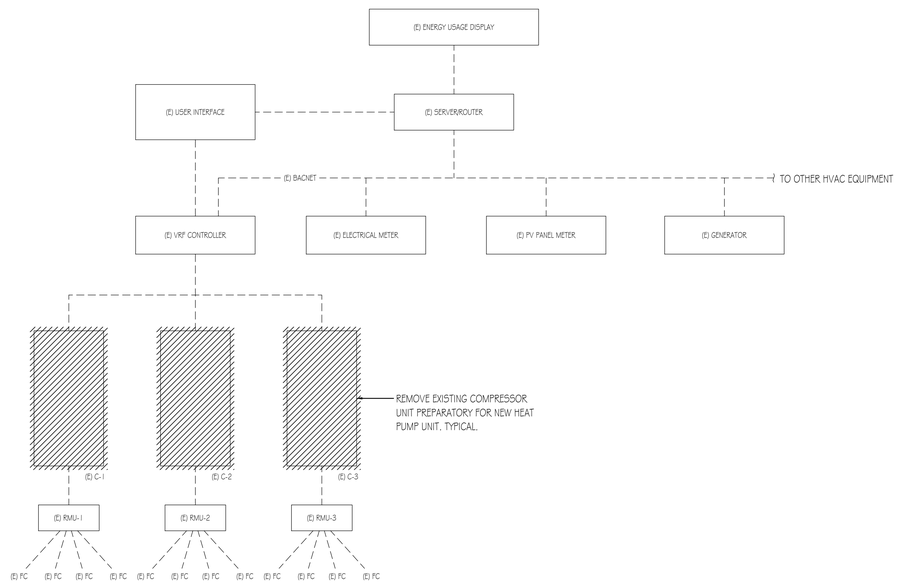
- MONITOR CO2 AND TEMPERATURE IN MEETING ROOMS, LOBBY, OPEN OFFICE, AND CONFERENCE ROOM. MODULATE CONTROL DAMPER TO MEET CO2 SETPOINT OF 800 PPM (ADJ.) OR COOLING TEMPERATURE SETPOINT OF 73°F (ADJ.).

- GENERATE ALARM IN CO2 > 900 PPM.



1 / MI601 ERV SCHEMATIC - EXISTING

SCALE: NONE



2 / MI601 CONTROL DIAGRAM - DEMOLITION

SCALE: NONE

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SHEET DESCRIPTION

EDUCATION CENTER

CONTROL DIAGRAMS - DEMOLITION

SHEET NUMBER

MI601

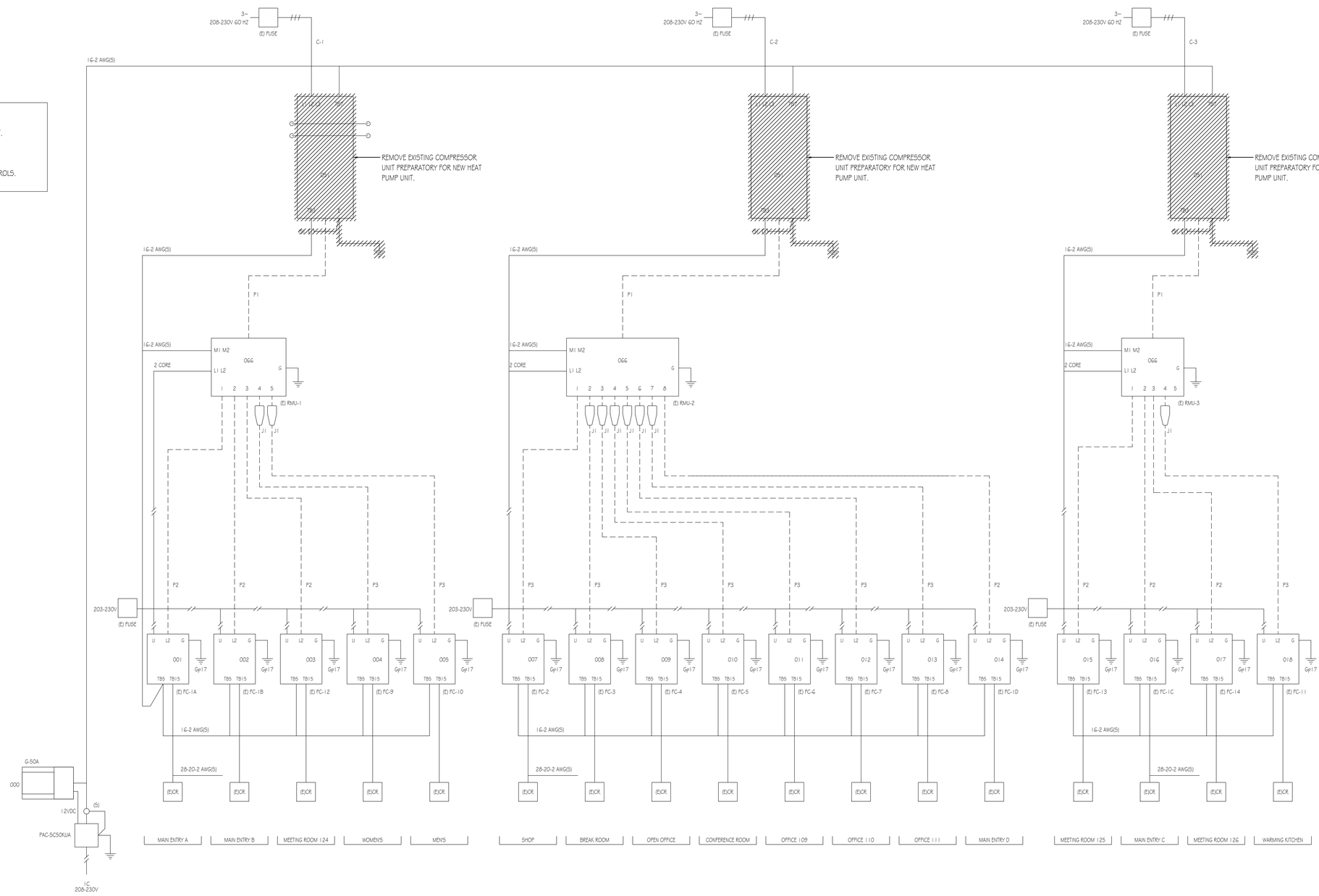
CONSTRUCTION DOCUMENTS

SEQUENCE OF OPERATION

-FACTORY CONTROLS START AND STOP VRG EQUIPMENT.

-MONITOR EQUIPMENT VIA BACNET INTERFACE.

-GENERATE ALARM FOR ANY ALARMS IN FACTORY CONTROLS.



1 MI602 **VRF CONTROL SCHEMATIC - DEMOLITION**
SCALE: NONE

HEATH Engineering Company

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No. 270896
ROBERT JACK KESLER
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CONSTRUCTION DOCUMENTS

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SHEET DESCRIPTION

EDUCATION CENTER

CONTROL DIAGRAMS - DEMOLITION

SHEET NUMBER

MI602

SEQUENCE OF OPERATION

- START ERV-1 WHEN BUILDING IS OCCUPIED.

- GENERATE ALARM IN A STATUS DOES NOT MATCH COMMAND.

- MODULATE SUPPLY FAN SPEED TO MAINTAIN SUPPLY DUCT STATIC PRESSURE SET POINT AT 0.1" W.G. (ADJ.).

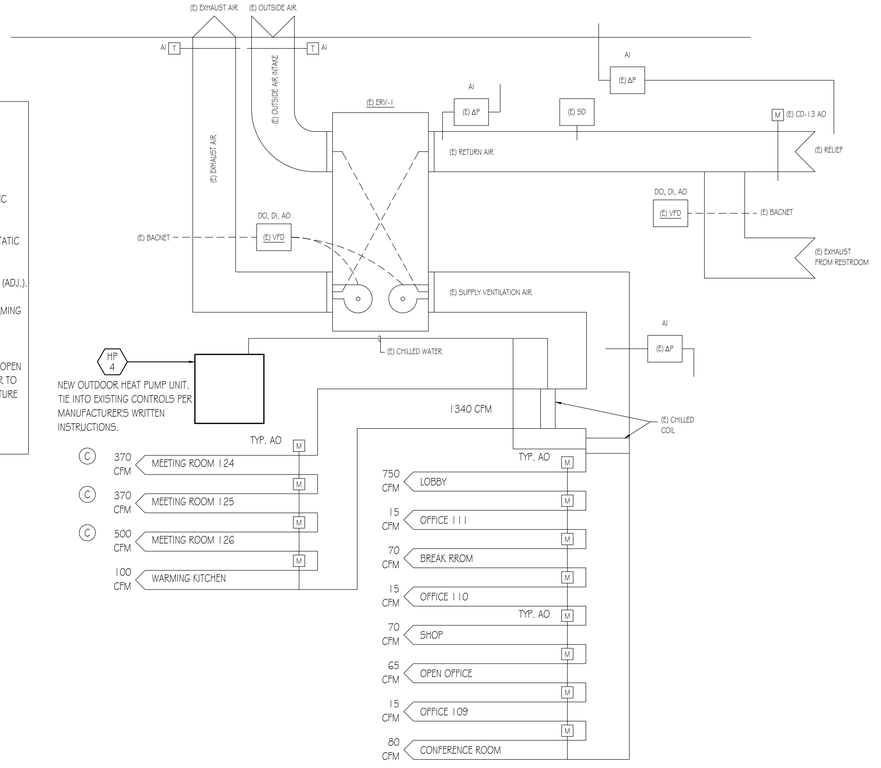
- MODULATE EXHAUST FAN SPEED TO MAINTAIN EXHAUST DUCT STATIC PRESSURE AT 0.1" W.G. (ADJ.)

- MODULATE CD-13 TO MAINTAIN BUILDING STATIC AT 0.05" W.G. (ADJ.).

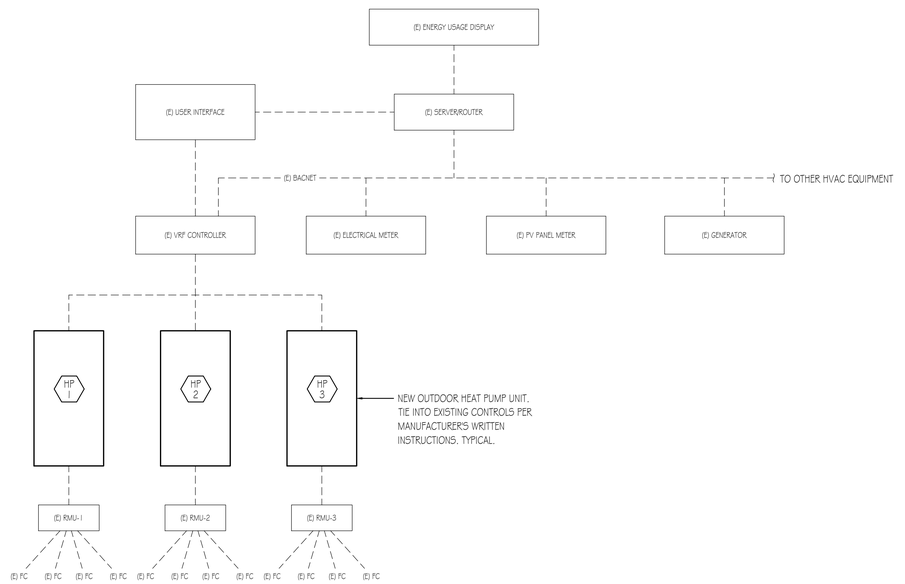
- MONITOR OCCUPANCY SENSOR IN OFFICES, BREAK ROOM, WARMING KITCHEN, CONFERENCE ROOM, AND GIFT SHOP. OPEN CONTROL DAMPER WHEN ROOM IS OCCUPIED.

- MONITOR CO2 AND TEMPERATURE IN MEETING ROOMS, LOBBY, OPEN OFFICE, AND CONFERENCE ROOM. MODULATE CONTROL DAMPER TO MEET CO2 SETPOINT OF 800 PPM (ADJ.) OR COOLING TEMPERATURE SETPOINT OF 73°F (ADJ.).

- GENERATE ALARM IN CO2 > 900 PPM.



1 MI603 **ERV SCHEMATIC - REMODEL**
SCALE: NONE



2 MI603 **CONTROL DIAGRAM - REMODEL**
SCALE: NONE

HEATH Engineering Company

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CONSTRUCTION DOCUMENTS

SHEET DESCRIPTION

EDUCATION CENTER

CONTROL DIAGRAMS - REMODEL

SHEET NUMBER

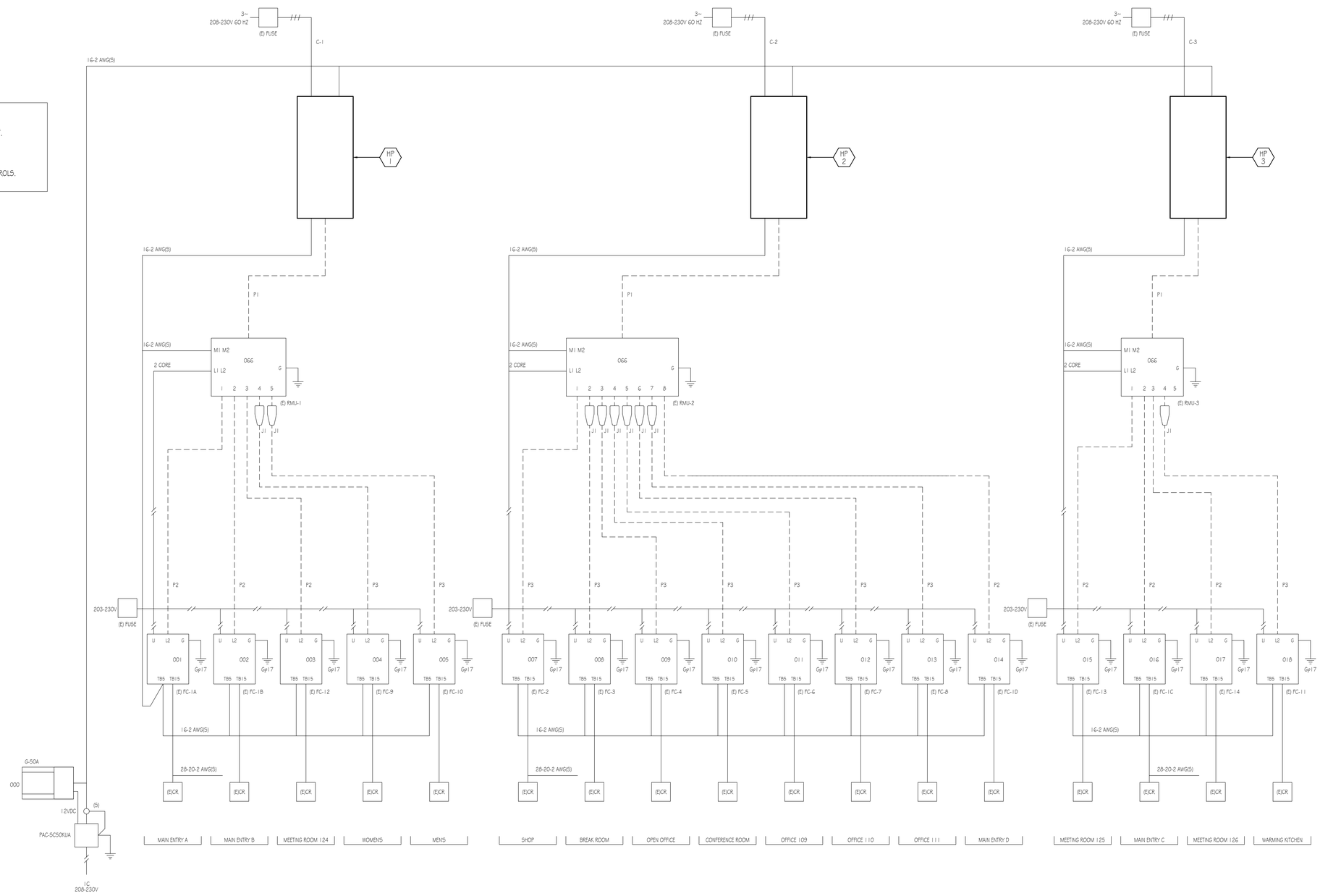
MI603

SEQUENCE OF OPERATION

-FACTORY CONTROLS START AND STOP VRG EQUIPMENT.

-MONITOR EQUIPMENT VIA BACNET INTERFACE.

-GENERATE ALARM FOR ANY ALARMS IN FACTORY CONTROLS.



1 MI604 VRF CONTROL SCHEMATIC - REMODEL

SCALE: NONE

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STATE OF UTAH

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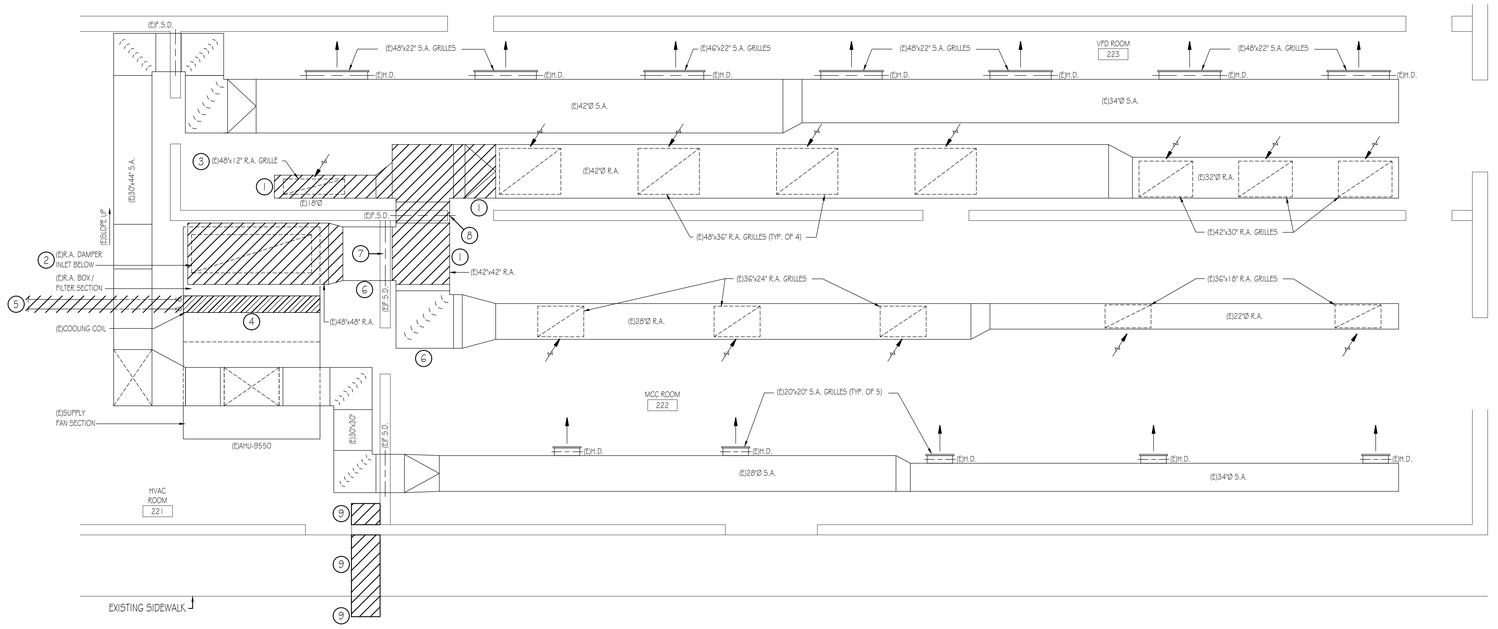
SHEET DESCRIPTION

EDUCATION CENTER

CONTROL DIAGRAMS - REMODEL

SHEET NUMBER

MI604



1 MD102 RO BUILDING VFD AND MCC ROOMS MECHANICAL DEMOLITION PLAN

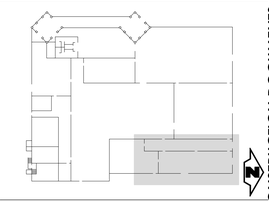
SCALE: 1/4" = 1'-0"

5 0 10

DRAWING NOTES

1. REMOVE PORTION OF RA DUCT INDICATED.
2. REMOVE RA DUCT ELBOW FITTING ABOVE RA OPENING IN AHU UNIT BELOW AND PORTION OF EXISTING RA RISER DUCT DROPPING DOWN TO THE RA OPENING IN THE UNIT BELOW AS NEEDED IN ORDER TO PROVIDE ACCESS TO THE ADJACENT WEST WALL FOR INSTALLATION OF RELOCATED RA FIRE DAMPER AND CONNECTING RA DUCT. HEIGHT OF THE OVERALL DUCTWORK RISER FROM THE TOP OF THE AIR HANDLING UNIT IS APPROXIMATELY 4'-9". ALSO REMOVE ANY SENSORS THAT MAY BE IMPACTED BY THE REMOVAL OF THIS RA DUCT AND SAVE IF REUSABLE FOR FUTURE REINSTALLATION. FIELD VERIFY EXACT CONDITIONS.
3. REMOVE RA GRILLE
4. REMOVE EXISTING HYDRONIC COOLING COIL IN AHU.
5. REMOVE EXISTING PLANT COOLING PIPING WITH RELATED VALVES, ETC. BACK TO THE LOCAL SHUTOFF VALVES AND CAP. FIELD VERIFY EXACT LOCATIONS.
6. THIS PORTION OF 42"x42" DUCTWORK TO REMAIN.
7. EXISTING FIRE SMOKE DAMPER ASSEMBLY TO REMAIN.
8. REMOVE AND RELOCATE EXISTING FIRE SMOKE DAMPER ASSEMBLY TO NEW LOCATION SHOWN ON THE REMODEL PLAN. SEE SHEET MH102.
9. COORDINATE WITH THE GENERAL CONTRACTOR TO SAWCUT A PORTION OF THE EXISTING FLOOR SLAB AND REMOVE A SECTION OF THE EXISTING SIDEWALK AS NEEDED IN ORDER TO EXCAVATE THE SOIL BELOW TO PREPARE FOR INSTALLATION OF NEW REFRIGERANT PIPING.

KEY PLAN



HEATH Engineering Company

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CONSTRUCTION DOCUMENTS

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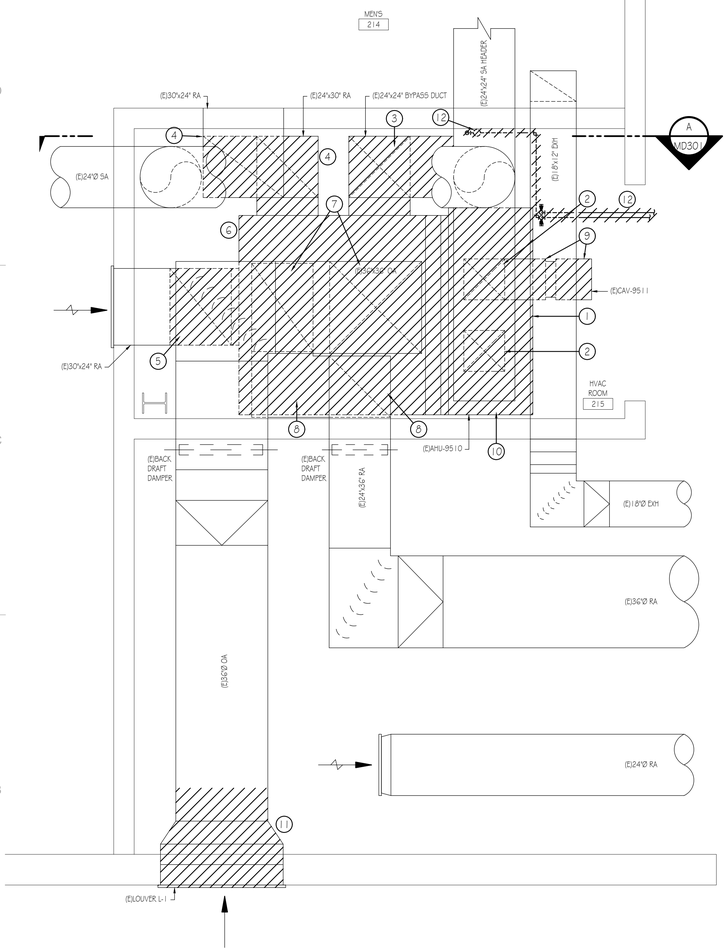
SHEET DESCRIPTION

SWGWTP

VFD AND MCC ROOMS MECHANICAL DEMOLITION PLAN

SHEET NUMBER

MD102



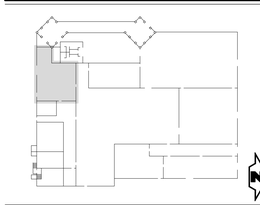
DRAWING NOTES

1. REMOVE EXISTING AIR HANDLING UNIT AND RELATED POWER AND CONTROLS WIRING.
2. REMOVE EXISTING SUPPLY AIR DUCT WORK EXTENDING FROM THE AIR HANDLING UNIT.
3. REMOVE 24"x24" BYPASS DUCT IN ITS ENTIRETY INCLUDING CONTROL DAMPER AND CONTROL WIRING.
4. REMOVE RETURN AIR DUCT EXTENDING FROM MIXING BOX UP TO RETURN AIR DUCT PENETRATION IN WALL ABOVE.
5. REMOVE RETURN AIR DUCT FROM MIXING BOX AND A PORTION OF THE RETURN AIR DUCT AS NEEDED ON ORDER TO RECONNECT TO THE NEW MIXING BOX. REFERENCE SHEET M301 FOR NEW LAYOUT.
6. REMOVE MIXING BOX IN ITS ENTIRETY INCLUDING SUPPORT LEGS.
7. REMOVE EXISTING OUTSIDE AIR DUCT EXTENDING FROM THE MIXING BOX TO THE FIRST ELBOW CONNECTING TO THE WALL PENETRATION.
8. REMOVE EXISTING RELIEF AIR DUCT / PLENUM EXTENDING FROM THE MIXING BOX TO THE WALL PENETRATION.
9. REMOVE AND RELOCATE EXISTING CONSTANT VOLUME BOX WITH ASSOCIATED SUPPLY RUNOUT DUCT AS NEEDED TO ACCOMMODATE INSTALLATION OF SUPPLY DUCT FROM NEW AIR HANDLING UNIT AND ELECTRICAL DUCT HEATER.
10. REMOVE PORTION OF MAIN 24"x24" SUPPLY AIR HEADER DUCT AS NEEDED TO ACCOMMODATE INSTALLATION OF SUPPLY DUCT FROM NEW AIR HANDLING UNIT AND ELECTRICAL DUCT HEATER.
11. REMOVE EXISTING 48"x24" LOUVER AND CONNECTING OUTSIDE AIR DUCTWORK AS NEEDED IN ORDER TO ACCOMMODATE INSTALLATION OF LARGER LOUVER.
12. REMOVE EXISTING PLANT WATER PIPING EXTENDING TO THE AIR HANDLING UNIT HEAT PUMP COIL FROM THE MAIN LINES INCLUDING ALL VALVES, PUMPS, ETC.. FIELD VERIFY EXACT LOCATION OF THE MAIN PLANT WATER LINES.
13. COORDINATE WITH THE GENERAL CONTRACTOR TO SAWCUT A PORTION OF THE EXISTING FLOOR SLAB AND REMOVE A SECTION OF THE EXISTING SIDEWALK AS NEEDED IN ORDER TO EXCAVATE THE SOIL BELOW TO PREPARE FOR INSTALLATION OF NEW REFRIGERANT PIPING.

1 MD103 — SWGWTP BUILDING MECHANICAL ROOM DEMOLITION PLAN
SCALE: 1/2" = 1'-0"

2 0 5

KEY PLAN



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ROBERT JACK KESLER
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SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

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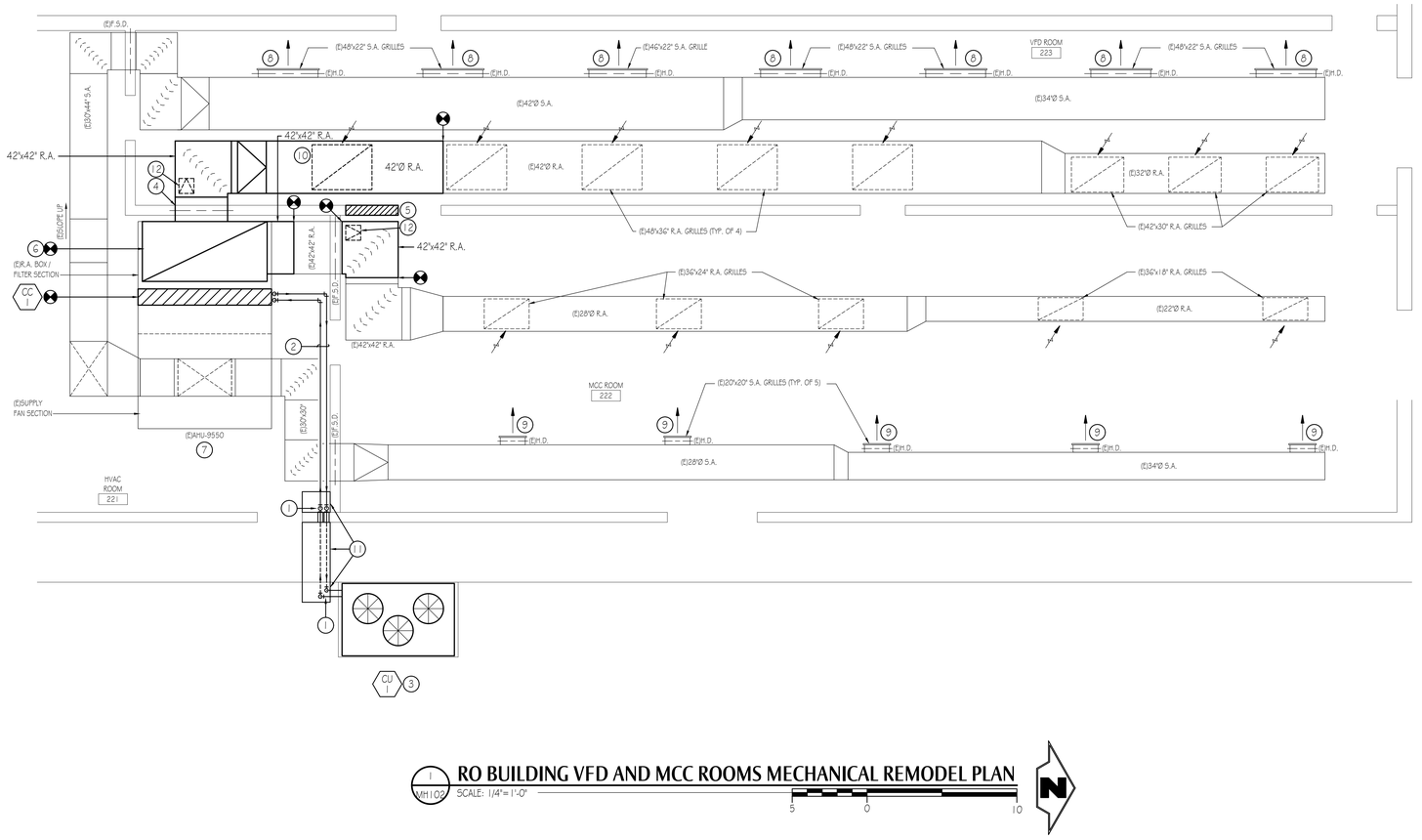
SHEET DESCRIPTION

SWGWTP

MECHANICAL ROOM DEMOLITION PLAN

SHEET NUMBER

MD103



1 MH102 RO BUILDING VFD AND MCC ROOMS MECHANICAL REMODEL PLAN

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

5 0 10

DRAWING NOTES

1. DROP REFRIGERANT PIPING AGAINST WALL THROUGH FLOOR OPENING PREVIOUSLY CREATED. CORE DRILL AND SLEEVE THROUGH WALL BELOW GRADE. ROUTE REFRIGERANT PIPING BELOW SIDEWALK IN AN ENCLOSED PIPE SLEEVE. RISE UP ABOVE GRADE AND EXTEND TO THE CONDENSING UNIT. REFERENCE DETAIL 7 / M-502 FOR BURIAL METHOD.
2. REFRIGERANT LIQUID AND SUCTION LINES. SEE DETAIL 5 / M-502 FOR REFRIGERANT PIPING SCHEMATIC. ROUTE REFRIGERANT PIPING AT APPROXIMATELY 9'-0" ABOVE THE FAN ROOM FLOOR HOLDING IT ABOVE THE EXISTING 30"x30" SA DUCT.
3. MOUNT ON 6" HOUSEKEEPING PAD. REFERENCE DETAIL 6 / M-502.
4. SAWCUT AND SLEEVE NEW 42"x42" WALL OPENING IN EXISTING BRICK WALL. COORDINATE WITH OWNER FOR EXACT LOCATION. RELOCATE 42"x42" FIRE SMOKE DAMPER TO THIS LOCATION AND REINSTALL. SEE DETAIL 7 / M-501.
5. FILL IN EXISTING WALL OPENING LEFT BY RELOCATION OF FIRE SMOKE DAMPER TO MATCH EXISTING FIRE RATING AND APPEARANCE OF ADJACENT WALL.
6. PROVIDE NEW 8'-4" L x 4'-0" W RA PLENUM ENCLOSING EXISTING RA OPENING IN THE AHU BELOW WITH HEIGHT AS REQUIRED TO CONNECT NEW 42"x42" RA DUCTS. APPROXIMATELY 4'-9" HIGH. REINSTALL ANY SENSORS PREVIOUSLY REMOVED RELATED TO THE RETURN AIR DUCT OR PROVIDE NEW. PROVIDE TO THE OWNER THE REPLACEMENT COST FOR ANY NEW SENSORS THAT MAY BE REQUIRED.
7. LOWER THE FAN SPEED OF THE EXISTING SUPPLY FAN IN ORDER TO PROVIDE 13,000 +/- TOTAL CFM. RE-SHEAVE IF REQUIRED.
8. BALANCE EACH SUPPLY AIR DIFFUSER FOR 1430 +/- CFM EACH.
9. BALANCE EACH SUPPLY AIR DIFFUSER FOR 600 +/- CFM EACH.
10. R-1 48"X36" NK RETURN AIR GRILLE
11. WHEN THE REFRIGERANT PIPING HAS BEEN PROPERLY INSTALLED AND TESTED, COORDINATE WITH THE GENERAL CONTRACTOR TO HAVE THE SOIL FILLED IN AND COMPACTED OVER THE INSTALLED REFRIGERANT PIPING THEN HAVE THE CONCRETE FLOOR AND SIDE WALK REINSTALLED, REPAIRED, AND TESTED TO MATCH EXISTING.
12. PROVIDE MINIMUM 12"x12" SIZE ACCESS DOOR TO SERVE FIRE / SMOKE DETECTOR.

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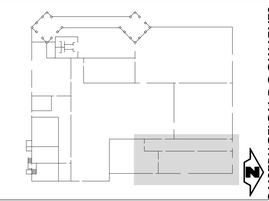
KEY PLAN



CONSTRUCTION DOCUMENTS

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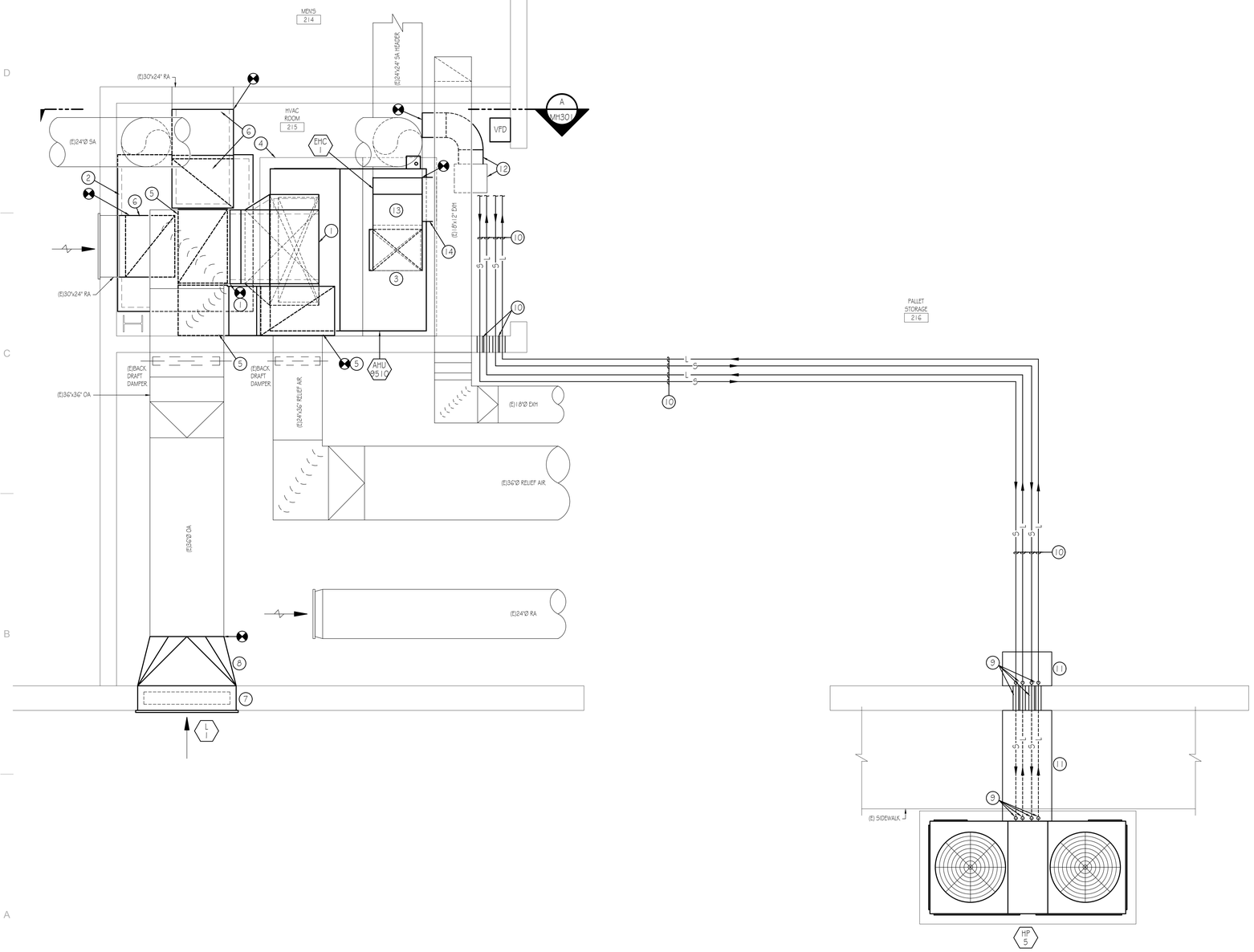
SHEET DESCRIPTION

SWGWTP

VFD AND MCC ROOMS MECHANICAL REMODEL PLAN

SHEET NUMBER

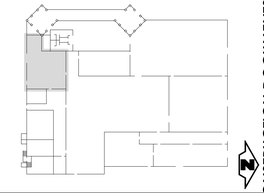
MH102



DRAWING NOTES

1. EXTEND 36"x36"+2"AL O.A. DUCT FROM THE EXISTING 36"x36" O.A. DUCT. DROP DOWN AND TRANSITION TO THE OUTSIDE AIR INLET IN THE AIR HANDLING UNIT.
2. PROVIDE SHEET METAL PLENUM LINED WITH 2" A.L., OVERALL DIMENSIONS 7'-0" HIGH, 5'-6" WIDE AND LENGTH AS REQUIRED TO ACCEPT TWO 24"x30" R.A. DUCTS AND ONE 24"x36" RELIEF AIR DUCT PLUS THE R.A. OPENING INTO THE AIR HANDLING UNIT. APPROXIMATELY 6'-3" ± LONG. PROVIDE WITH MINIMUM 2'-6" x 5' ACCESS DOOR MOUNTED ON THE NORTH SIDE OF THE PLENUM.
3. TRANSITION FROM SUPPLY AIR OUTLET ON FAN TO 24"x24".
4. PROVIDE ADDITIONAL CONCRETE PAD TYING INTO AND MATCHING THE HEIGHT OF THE EXISTING PAD WITH AREA AS NEEDED TO SUPPORT THE NEW AIR HANDLING UNIT. REFERENCE DETAIL 6 / M-502 FOR METHOD OF CONSTRUCTION.
5. ENCLOSE EXISTING 24"x36" RELIEF AIR OPENING IN WALL. DROP A 36"x24" DUCT DOWN AGAINST WALL TO PASS BELOW O.A. DUCT. TURN WITH 90 DEG. ELBOW TO RUN OVER R.A. PLENUM. DROP DOWN AND OPEN INTO R.A. PLENUM. PROVIDE MOTORIZED DAMPER AT R.A. PLENUM PENETRATION.
6. EXTEND 24"x30"+ 1"AL R.A. DUCT DOWN FROM EXISTING 24"x30" R.A. DUCT TO R.A. PLENUM AND OPEN INTO PLENUM.
7. ENLARGE EXISTING OPENING BY SAWCUTTING TO ALLOW FOR INSTALLATION OF LARGER OUTSIDE AIR LOUVER.
8. TRANSITION FROM THE NEW OUTSIDE LOUVER TO EXISTING ROUND OUTSIDE AIR DUCT.
9. DROP REFRIGERANT PIPING AGAINST WALL THROUGH FLOOR OPENING PREVIOUSLY CREATED. CORE DRILL AND SLEEVE THROUGH WALL BELOW GRADE. ROUTE REFRIGERANT PIPING BELOW SIDEWALK IN AN ENCLOSED PIPE SLEEVE. RISE UP ABOVE GRADE AND EXTEND TO THE HEAT PUMP UNIT. REFERENCE DETAIL 7 / M-502 FOR BURIAL METHOD.
10. TWO REFRIGERANT LIQUID AND SUCTION LINES. SEE DETAIL 5 / M-502 FOR REFRIGERANT PIPING SCHEMATIC. ROUTE REFRIGERANT PIPING TIGHT BELOW THE EXISTING EXHAUST DUCTWORK AND FOLLOWING THE ROUTING OF THE EXISTING EXHAUST DUCTWORK. CORE DRILL AND SLEEVE NEW PENETRATIONS AT THE FAN ROOM EXTERIOR WALL. EXTEND REFRIGERATION PIPING THROUGH THE NEW OPENINGS INTO THE FAN ROOM AND CONNECT TO THE AHU DX COOLING COIL FOLLOWING MANUFACTURER'S INSTALLATION INSTRUCTIONS.
11. WHEN THE REFRIGERANT PIPING HAS BEEN PROPERLY INSTALLED AND TESTED, COORDINATE WITH THE GENERAL CONTRACTOR TO HAVE THE SOIL FILLED IN AND COMPACTED OVER THE INSTALLED REFRIGERANT PIPING THEN HAVE THE CONCRETE FLOOR AND SIDE WALK REINSTALLED, REPAIRED, AND TESTED TO MATCH EXISTING.
12. RELOCATE CONSTANT VOLUME BOX CAV-95 1 TO THIS LOCATION EXTEND BRANCH DUCTWORK FROM MAIN S.A. DUCT TO MATCH EXISTING. (APPROXIMATELY 12" DIA.).
13. PROVIDE NEW SECTION OF 24"x24" SA DUCTWORK BETWEEN SA RISER AND THE ELECTRICAL HEATING COIL.
14. ELECTRICAL HEATING COIL CONTROL PANEL

KEY PLAN



RO BUILDING MECHANICAL ROOM REMODEL PLAN

1 / MH103 SCALE: 1/2" = 1'-0"

2 0 5

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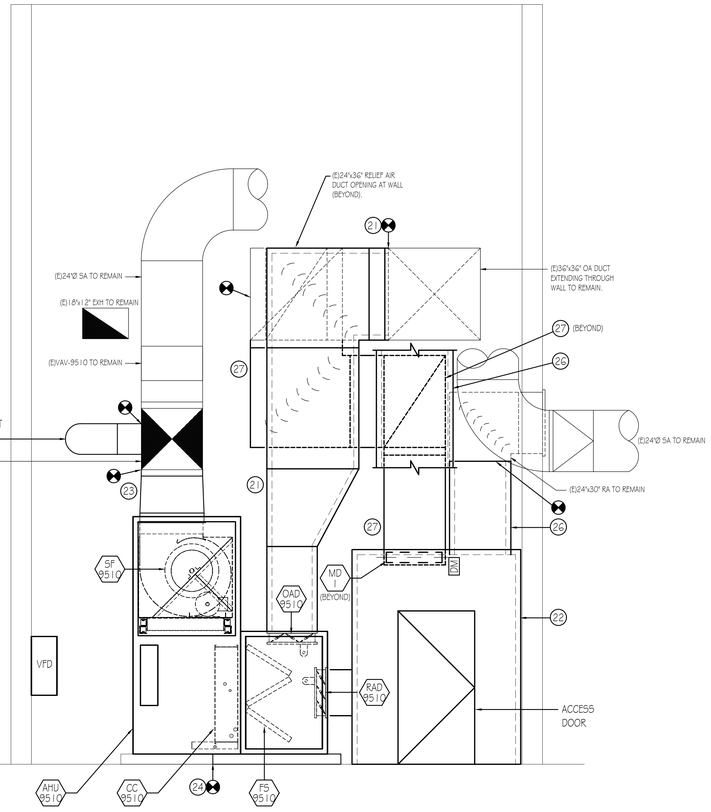
SHEET DESCRIPTION

SWGWTP

MECHANICAL ROOM REMODEL PLAN

SHEET NUMBER

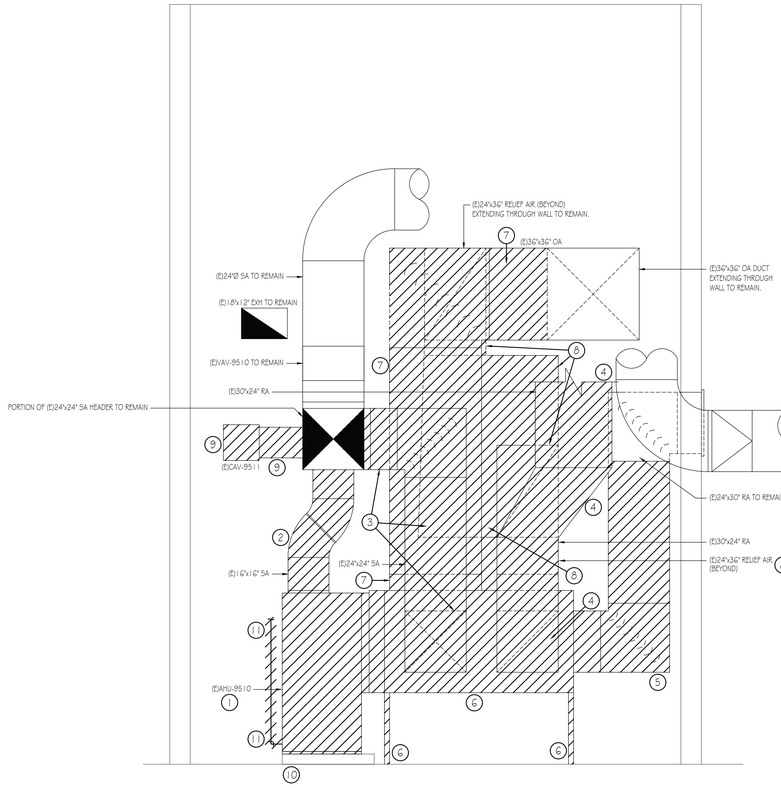
MH103



B MH301 HVAC ROOM 215 REMODEL SECTION

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

2 0 5



A MH301 HVAC ROOM 215 DEMOLITION SECTION

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

2 0 5

DEMOLITION NOTES

1. REMOVE EXISTING AIR HANDLING UNIT AND RELATED POWER AND CONTROLS WIRING.
2. REMOVE EXISTING SUPPLY AIR DUCT WORK EXTENDING FROM THE AIR HANDLING UNIT.
3. REMOVE 24"x24" BYPASS DUCT IN ITS ENTIRETY INCLUDING CONTROL DAMPER AND CONTROL WIRING.
4. REMOVE RETURN AIR DUCT EXTENDING FROM MIXING BOX UP TO RETURN AIR DUCT PENETRATION IN WALL ABOVE.
5. REMOVE RETURN AIR DUCT FROM MIXING BOX AND A PORTION OF THE RETURN AIR DUCT AS NEEDED ON ORDER TO RECONNECT TO THE NEW MIXING BOX. REFERENCE SHEET M301 FOR NEW LAYOUT.
6. REMOVE MIXING BOX IN ITS ENTIRETY INCLUDING SUPPORT LEGS.
7. REMOVE EXISTING OUTSIDE AIR DUCT EXTENDING FROM THE MIXING BOX TO THE FIRST ELBOW CONNECTING TO THE WALL PENETRATION.
8. REMOVE EXISTING RELIEF AIR DUCT / PLENUM EXTENDING FROM THE MIXING BOX TO THE WALL PENETRATION.
9. REMOVE AND RELOCATE EXISTING CONSTANT VOLUME BOX WITH ASSOCIATED SUPPLY RUNOUT DUCT AS NEEDED TO ACCOMMODATE INSTALLATION OF SUPPLY DUCT FROM NEW AIR HANDLING UNIT AND ELECTRICAL DUCT HEATER.
10. EXISTING 4" CONCRETE PAD TO REMAIN.
11. REMOVE EXISTING PLANT WATER PIPING EXTENDING TO THE AIR HANDLING UNIT HEAT PUMP COIL FROM THE MAIN LINES INCLUDING ALL VALVES, PUMPS, ETC.. FIELD VERIFY EXACT LOCATION OF THE MAIN PLANT WATER LINES.

REMODEL NOTES

21. EXTEND 36"x36"+2"AL O.A. DUCT FROM THE EXISTING 36"x36" O.A. DUCT. DROP DOWN AND TRANSITION TO THE OUTSIDE AIR INLET IN THE AIR HANDLING UNIT.
22. PROVIDE SHEET METAL PLENUM LINED WITH 2" A.L., OVERALL DIMENSIONS 7'-0" HIGH, 5'-6" WIDE AND LENGTH AS REQUIRED TO ACCEPT TWO 24"x30" R.A. DUCTS AND ONE 24"x36" RELIEF AIR DUCT PLUS THE R.A. OPENING INTO THE AIR HANDLING UNIT. APPROXIMATELY 6'-3" ± LONG. PROVIDE WITH MINIMUM 2'-6" x 5' ACCESS DOOR MOUNTED ON THE NORTH SIDE OF THE PLENUM.
23. TRANSITION FROM SUPPLY AIR OUTLET ON FAN TO 24"x24"
24. PROVIDE ADDITIONAL CONCRETE PAD TYING INTO AND MATCHING THE HEIGHT OF THE EXISTING PAD WITH AREA AS NEEDED TO SUPPORT THE NEW AIR HANDLING UNIT.
25. NOT USED.
26. EXTEND 24"x30"+1"AL R.A. DUCT DOWN FROM EXISTING 24"x30" R.A. DUCT TO R.A. PLENUM AND OPEN INTO PLENUM.
27. ENCLOSE EXISTING 24"x36" RELIEF AIR OPENING IN WALL. DROP A 36"x24" DUCT DOWN AGAINST WALL TO PASS BELOW O.A. DUCT. TURN WITH 90 DEG. ELBOW TO RUN OVER R.A. PLENUM. DROP DOWN AND OPEN INTO R.A. PLENUM. PROVIDE MOTORIZED DAMPER AT R.A. PLENUM PENETRATION.

HEATH
Engineering Company

STAMP

LICENSED PROFESSIONAL ENGINEER
No. 270896
ROBERT JACK KESLER
STATE OF UTAH

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	RJK
DRAWN BY:	KGM
DATE:	November 14, 2023

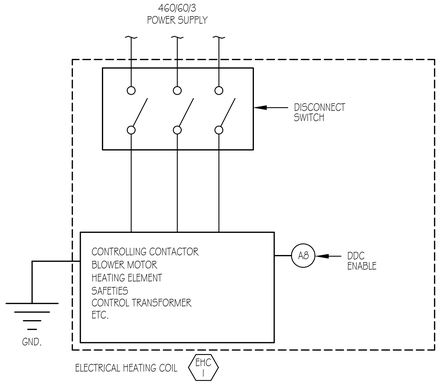
SHEET DESCRIPTION

SWGWTP

MECHANICAL ROOM SECTIONS

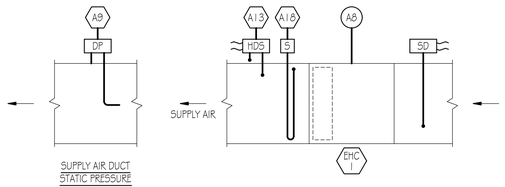
SHEET NUMBER

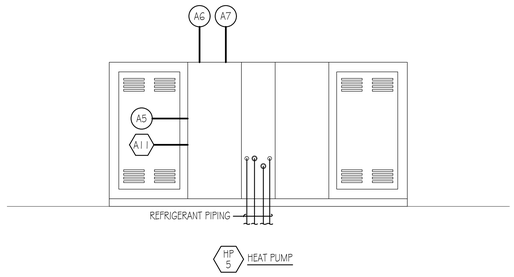
MH301

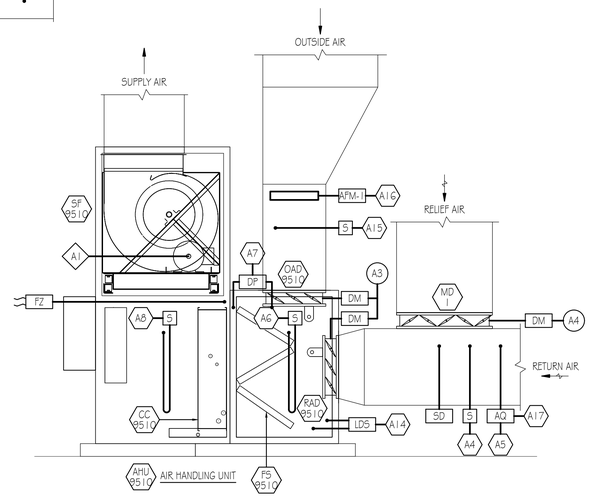


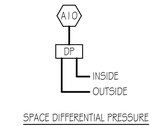
1 M1604 **ELECTRICAL HEATING COIL EHC-1 CONTROL DIAGRAM**

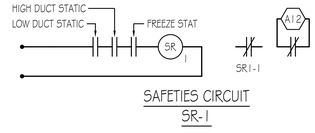
SCALE: NONE

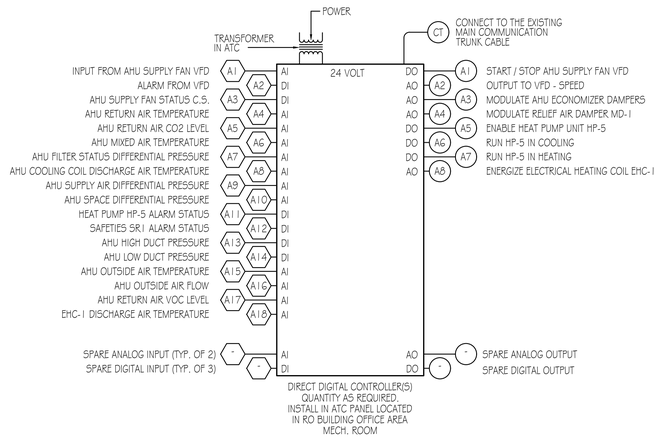












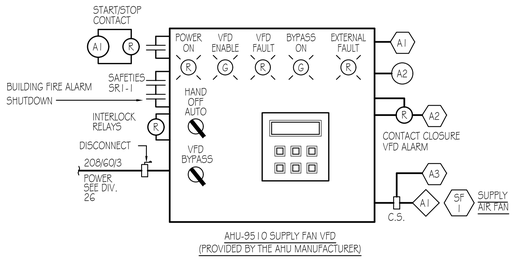
DDC POINTS LIST

SCALE: NONE

GENERAL NOTES

A. CONTROLS CONTRACTOR HAS THE OPTION TO CONNECT ALL NEW CONTROLS FOR THE NEW AIR HANDLING UNIT INTO THE EXISTING DDC CONTROLLER IN THE EXISTING ATC PANEL. PROVIDE EXPANSION MODULE AS REQUIRED.

B. FOR THE NEW CONDENSING UNIT CU-1 SERVING AHU-9550, EXTEND CONTROL WIRING FROM A SPARE DIGITAL OUTPUT IN THE EXISTING DDC CONTROLLER SERVING AHU-9550 TO THE CONDENSING UNIT CONTROL PANEL, TO ENABLE THE CONDENSING UNIT TO RUN ON CALL FOR COOLING. ALSO EXTEND CONTROL WIRING FROM A SPARE DIGITAL INPUT IN THE EXISTING DDC CONTROLLER SERVING AHU-9550 TO THE CONDENSING UNIT CONTROL PANEL, TO MONITOR CONDENSING UNIT STATUS.



AIR HANDLING UNIT AHU-9510 CONTROL DIAGRAM

SCALE: NONE

HEATH
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STAMP

LICENSED PROFESSIONAL ENGINEER
No. 270896
ROBERT JACK KESLER
STATE OF UTAH

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HEATH PROJECT No:	22099
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CONSTRUCTION DOCUMENTS

SHEET DESCRIPTION

SWGWTP

CONTROL DIAGRAMS - REMODEL

SHEET NUMBER

MI605

ELECTRICAL PROJECT NOTES

1. THE COMPLETED INSTALLATION SHALL COMPLY WITH APPLICABLE FEDERAL, STATE, AND LOCAL CODES, ORDINANCES, AND REGULATIONS. THE CONTRACTOR SHALL OBTAIN NECESSARY PERMITS AND INSPECTIONS REQUIRED BY THE AUTHORITIES HAVING JURISDICTION. ALL WORK SHALL BE COMPLETED IN A NEAT, WORKMANLIKE MANNER IN ACCORDANCE WITH THE LATEST NECA STANDARDS OF INSTALLATION UNDER COMPETENT SUPERVISION. INSTALL GROUNDING PER NEC.

2. VISIT THE SITE PRIOR TO BIDDING TO BECOME FAMILIAR WITH EXISTING CONDITIONS AND OTHER FACTORS, WHICH MAY EFFECT THE EXECUTION OF THE WORK. INCLUDE ALL RELATED COSTS IN THE INITIAL BID PROPOSAL.

3. ALL MATERIALS SHALL BE NEW AND OF THE BEST QUALITY, MANUFACTURED IN ACCORDANCE WITH NEMA, ANSI, UL, OR OTHER APPLICABLE STANDARDS. THE USE OF MANUFACTURERS' NAMES, MODELS, AND NUMBERS IS INTENDED TO ESTABLISH STYLE, QUALITY, APPEARANCE, USEFULNESS, AND BID PRICE.

4. PROTECT ALL ELECTRICAL MATERIAL AND EQUIPMENT INSTALLED AGAINST DAMAGE BY OTHER TRADES, WEATHER CONDITIONS, OR ANY OTHER PREVENTABLE CAUSES. EQUIPMENT DAMAGED DURING SHIPPING OR CONSTRUCTION, PRIOR TO ACCEPTANCE BY THE ENGINEER OR THE OWNER, WILL BE REJECTED AS DEFECTIVE.

5. LEAVE THE SITE CLEAN. REMOVE ALL DEBRIS, EMPTY CARTONS, TOOLS, CONDUIT, WIRE SCRAPS AND ALL MISCELLANEOUS SPARE EQUIPMENT AND MATERIALS USED IN THE WORK DURING CONSTRUCTION. ALL COMPONENTS SHALL BE FREE OF DUST, GRIT AND FOREIGN MATERIALS, LEFT AS NEW BEFORE FINAL ACCEPTANCE OF WORK. DAMAGED PAINT AND FINISHES SHALL BE TOUCHED UP OR REPAINTED WITH MATCHING COLOR PAINT AND FINISH.

6. CIRCUIT CONDUCTORS #6 AWG OR SMALLER SHALL BE THWN / THHN STRANDED COPPER. #4 AWG THROUGH #2 AWG SHALL BE THWN / THHN STRANDED COPPER. #1 AWG OR LARGER SHALL BE THWN-2 / THHN-2 STRANDED COPPER. MINIMUM POWER CONDUCTOR SIZE SHALL BE #12 AWG WITH #12 AWG GROUND.

7. UNDERGROUND CONDUITS SHALL BE SCHEDULE 40 PVC. MINIMUM CONDUIT DEPTH SHALL BE 24". MINIMUM UNDERGROUND CONDUIT SIZE SHALL BE 1".

8. CONDUITS SHALL BE MARKED AT EACH END. SPARE CONDUITS SHALL HAVE A PULL STRING INSTALLED AND SECURED.

9. CONDUIT RISERS THROUGH THE FLOOR SHALL BE PVC COATED GALVANIZED RIGID STEEL (GRS). MINIMUM SIZE 3/4" UNLESS OTHERWISE NOTED ON THE PLANS. ALL UNDERGROUND ELBOWS TO BE PVC COATED GRS.

10. SAFETY SWITCHES, ELECTRICAL DISTRIBUTION EQUIPMENT, CONTROL PANELS, AND OTHER ELECTRICAL DEVICES SHALL BE UL LISTED, AND RATED FOR HEAVY DUTY SERVICE.

11. WIRING DEVICES SHALL BE SPECIFICATION GRADE.

12. THE CONTRACTOR IS RESPONSIBLE FOR MANAGING, SCHEDULING, DOCUMENTING, AND PERFORMING THE WORK SO THAT A COMPLETE ELECTRICAL, INSTRUMENTATION AND CONTROL SYSTEM FOR THE FACILITY IS PROVIDED. ACCURATE SHOP AND RECORD DRAWINGS, AND OEM MANUALS SHALL BE SUBMITTED PRIOR TO FINAL ACCEPTANCE OF THE WORK.

13. TYPICAL DETAILS SHALL APPLY IN ALL CASES, WHETHER SPECIFICALLY REFERRED TO OR NOT.

14. ANY OPEN WIRE IN CEILING SPACE SHALL BE PLENUM RATED.

15. CONDUIT SHALL BE EMT, GRC AND NOT MORE THAN 6' LFMC IN EDUCATION CENTER. UNDERGROUND CONDUIT SHALL BE SCH. 40 PVC WITH PVC COATED GRC ELBOWS AND RISERS.

16. CONDUIT SHALL BE GRC AND NOT MORE THAN 6' LFMC IN RO PLANT. UNDERGROUND CONDUIT SHALL BE SCH. 40 PVC WITH PVC COATED GRC ELBOWS AND RISERS.

SCHEMATICS & DIAGRAMS

SYMBOL	DESCRIPTION
■	TERMINAL LUG OR STRIP
	TRANSFORMER
	GROUND CONNECTION
	BOND TO METALLIC WATER PIPE
	BOND TO METALLIC WATER PIPE
	BOND TO BUILDING STEEL
G	GENERATOR

LIGHTING

SYMBOL	DESCRIPTION
	FLUORESCENT LIGHT FIXTURE, SEE FIXTURE SCHEDULE.
	EMERGENCY LIGHTING, SEE FIXTURE SCHEDULE.
F#	LIGHTING FIXTURE TYPE - SEE FIXTURE SCHEDULE.
$	SINGLE POLE SWITCH
$3	3 WAY SWITCH
$m	WALL MOUNTED MOTION SWITCH - DUAL TECHNOLOGY
$T	MOTOR RATED TOGGLE SWITCH
$D	DIGITAL OVERRIDE SWITCH
$P	SINGLE POLE SWITCH WITH PILOT LIGHT
SP	RECESSED CEILING MOUNTED SPEAKER BY OTHERS
	WALL MOUNTED MOTION SENSOR
	CEILING MOUNTED MOTION SENSOR
	CEILING-MOUNTED EXIT LIGHT, SEE FIXTURE SCHEDULE
	WALL-MOUNTED EXIT LIGHT, SEE FIXTURE SCHEDULE
	RECESSED CAN LIGHT, SEE FIXTURE SCHEDULE

CONTROLS & INSTRUMENTS

SYMBOL	DESCRIPTION
AE	ANALYZER ELEMENT
AIT	ANALYZING INDICATING TRANSMITTER
CGS	COMBUSTIBLE GAS DETECTOR
CIT	CONDUCTIVITY INDICATING TRANSMITTER
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
FS	FLOW SWITCH
LE	LEVEL ELEMENT
LIT	LEVEL INDICATING TRANSMITTER
LS	LEVEL SWITCH
LT	LEVEL TRANSMITTER
ME	MOISTURE ELEMENT
MV	MOTOR OPERATED VALVE OR GATE
OS	OVER TORQUE SWITCH
PIT	PRESSURE INDICATING TRANSMITTER
PS	PRESSURE SWITCH
SV	SOLENOID OPERATED VALVE
TE	TEMPERATURE ELEMENT
TS	TEMPERATURE SWITCH
TT	TEMPERATURE TRANSMITTER
ZS	LIMIT OR POSITION SWITCH
DS	DOOR SWITCH

SCHEMATICS & DIAGRAMS

SYMBOL	DESCRIPTION
	EMERGENCY STOP PUSH BUTTON (MAINTAINED)
	NORMALLY CLOSED PUSH BUTTON
	LOCKOUT STOP PUSH BUTTON
	NORMALLY OPEN PUSH BUTTON
T.C.	CONTACT - TIME DELAY T.C. = NORMALLY OPEN WITIME DELAY CLOSING. I.C. - T.O. = NORMALLY OPEN WITH INSTANT CLOSING AND TIME DELAY OPENING. T.C.-T.O. = NORMALLY OPEN WITIME DELAY CLOSING AND TIME DELAY OPENING AFTER DEENERGIZATION.
T.O.	CONTACT - TIME DELAY T.C. = NORMALLY CLOSED WITH TIME DELAY OPENING. T.O.-T.C. = NORMALLY CLOSED WITH TIME DELAY OPENING AND TIME DELAY CLOSING AFTER DEENERGIZATION. I.O.-T.C. = NORMALLY CLOSED WITH INSTANT OPENING AND TIME DELAY CLOSING.
	NORMALLY OPEN CONTACT
	NORMALLY CLOSED CONTACT
	LIMIT SWITCH
	PRESSURE SWITCH LOW
	PRESSURE SWITCH HIGH
	FLOW SWITCH
	LEVEL FLOAT SWITCH
	TEMPERATURE SWITCH
AMPS / POLES	DISCONNECT SWITCH SHOWN WITH RATING AND NUMBER OF POLES.
	FUSEHOLDER OR FUSEBLOCK
AMPS POLES	CIRCUIT BREAKER OR MOTOR CIRCUIT PROTECTOR, SHOWN WITH TRIP RATING AND NUMBER OF POLES.
H O A OOX	3 POSITION SELECTOR SWITCH HAND - OFF - AUTO, POSITION LEGEND: X=CLOSED O=OPEN
ON OFF XO	2 POSITION SELECTOR SWITCH, POSITION LEGEND: X=CLOSED O=OPEN
OCTO	TIMER RELAY CONTACT INSTANTANEOUS CLOSE TIME DELAY OPEN.
NOTC	TIMER RELAY CONTACT NORMALLY OPEN TIME DELAY CLOSE.
5	FULL VOLTAGE NONREVERSING (FVNR) MOTOR STARTER OR CONTACTER NUMBER DESIGNATES NEMA SIZE.
	RTU, PLC, OR RIO CONTACT
UM	UTILITY METER
X	BEACON ALARM LIGHT. LETTER INDICATES COLOR: R=RED, A=AMBER, B=BLUE, G=GREEN
X	PILOT LIGHT. LETTER INDICATES COLOR: R=RED, A=AMBER, B=BLUE, G=GREEN
R	RELAY
TD	TIME DELAY RELAY
AR	ALARM RELAY
ETM	ELAPSED TIME METER
M	MOTOR STARTER OR CONTACTOR COIL
EOL	ELECTRONIC OVERLOAD RELAY
SSRV	SOLID STATE REDUCED VOLTAGE STARTER
VFD	VARIABLE FREQUENCY DRIVE
HF	HARMONIC FILTER
CTS	CURRENT TRANSFORMER
	THERMAL OVERLOAD RELAY
	LTC CONNECTION
	MC CONNECTION
X	MOTOR, X = HORSEPOWER
	DEVICE LOCATED AT REMOTE LOCATION.
	FUSE
	NODE OR CONNECTION

POWER

SYMBOL	DESCRIPTION
	DUPLEX RECEPTACLE
	DUPLEX RECEPTACLE, RECESSED FLOOR MOUNTED
	DUPLEX RECEPTACLE, RECESSED CEILING MOUNTED
	QUADRAPLEX RECEPTACLE
	QUADRAPLEX RECEPTACLE, RECESSED FLOOR MOUNTED
	QUADRAPLEX RECEPTACLE, RECESSED CEILING MOUNTED
	ISOLATED GROUND TYPE DUPLEX RECEPTACLE
	SPECIAL PURPOSE OR WELDING OUTLET.
GFCI	GROUND FAULT CIRCUIT INTERRUPTER RECEPTACLE.
WP	WEATHERPROOF CONVENIENCE OUTLET
	FLUSH FLOOR DEVICE BOX
	HOME RUN TO PANEL - INDICATING 2 #12, #12 GND, 3/4" CONDUIT OR AS SHOWN.
	HOME RUN TO PANEL - INDICATING NUMBER OF CONDUCTORS - #12 OR AS SHOWN.
X-1,3,5	HOME RUN TO PANEL SHOWING BRANCH CIRCUIT NUMBERS.
	HATCH MARKS IN CONDUIT RUN DENOTES NUMBER OF CONDUCTORS IN CONDUIT. LONG HATCH MARK DENOTES GROUND CONDUCTOR. SIZE OF CONDUCTORS TO BE #12 AWG CONDUCTORS IN CONDUIT UNLESS NOTED OTHERWISE. UNMARKED CONDUITS SHALL BE 3/4" WITH 3 #12.
(E)	DENOTES EXISTING EQUIPMENT OR DEVICES
T	THERMOSTAT
X M	MOTOR, X = HORSE POWER
F	CEILING EXHAUST FAN
J	JUNCTION BOX
	ELECTRICAL PANEL, POWER OR LIGHTING
	METER BASE
	COMBINATION MOTOR STARTER, SEE SPECS
	DISCONNECT SWITCH. (VOLTAGE RATING, NEMA ENCLOSURE, FUSE (NF-NO FUSE), POLES, SIZE (AMPS))
+0'-0"	THIS NOTATION ADJACENT TO WALL OUTLET SYMBOL DENOTES MOUNTING HEIGHT ABOVE FINISHED FLOOR TO CENTER OF OUTLET DEVICE. IF NOT NOTED, THE MOUNTING HEIGHT TO CENTER SHALL BE AS DETAILED OR SPECIFIED.
$M	MANUAL MOTOR STARTER
$T	MANUAL MOTOR STARTER WITH OVERLOADS
DM	DAMPER MOTOR
F#	LIGHTING FIXTURE TYPE - SEE FIXTURE SCHEDULE.
$	SINGLE POLE SWITCH
$3	3 WAY SWITCH
$4	4 WAY SWITCH
	COMMUNICATION/DATA JACK. CONDUIT TO ABOVE CEILING. OWNER TO RUN WIRING.
	DATA OR CATHODE RAY TUBE (CRT) TERMINAL OUTLET. + 1'-6". (SINGLE, DOUBLE)
	TELEPHONE JACK OUTLET. 1'-6". (SINGLE, DOUBLE, QUAD)

FEEDER DESIGNATION LOGIC

G | I | P: 2 / N: 3 / G: 4 | 5

1. NUMBER OF CONDUITS
2. P: NUMBER - SIZE OF PHASE CONDUCTORS PER CONDUIT
3. N: NUMBER - SIZE OF NEUTRAL CONDUCTOR(S) PER CONDUIT
4. G: NUMBER- SIZE OF GROUND CONDUCTOR(S) PER CONDUIT
5. SIZE OF EACH CONDUIT IN INCHES
6. CONDUIT NUMBER

KEY TO CONDUCTOR SIZE & TYPE

14 = #14 AWG COPPER	6 = #6 AWG COPPER	1/0 = 1/0 AWG COPPER	250 = 250 KCMIL COPPER
12 = #12 AWG COPPER	4 = #4 AWG COPPER	2/0 = 2/0 AWG COPPER	350 = 350 KCMIL COPPER
10 = #10 AWG COPPER	2 = #2 AWG COPPER	3/0 = 3/0 AWG COPPER	500 = 500 KCMIL COPPER
8 = #8 AWG COPPER		4/0 = 4/0 AWG COPPER	750 = 750 KCMIL COPPER

ABBREVIATIONS

A	AMPERE	N	NEUTRAL
AFF	ABOVE FINISHED FLOOR	NEC	NATIONAL ELECTRICAL CODE
AI	ANALOG INPUT	NECA	NATIONAL ELECTRICAL CONTRACTOR ASSOCIATION
AIC	AMPS INTERRUPTING CAPACITY		
AFD	ADJUSTABLE FREQUENCY DRIVES	NOTC	NORMALLY OPEN TIMED CLOSED
AO	ANALOG OUTPUT	NPW	NON-POTABLE WATER
AS	AIR SUPPLY	NS	NITROGEN SUPPLY
ATS	AUTOMATIC TRANSFER SWITCH	NTS	NOT TO SCALE
		NTU	TURBIDITY
BC	BYPASS CONTACTOR	O.C.	ON CENTER
C	CONDUIT	OF	OVERFLOW
CB	CIRCUIT BREAKER	OIT	OPERATOR INTERFACE TERMINAL
CL2	CHLORINE	OL	OVERLOAD
CON	CONTACTOR	OO	ON/OFF (MAINTAINED)
CPM	CUSTOMER POWER MONITORING	OR	OFF-REMOTE
CPT	CONTROL POWER TRANSFORMER		
CU	COPPER, BARE	P	PHASE OR POLE
CV	CONTROL VALVE	PB	PULL BOX
		PCP	PROCESS CONTROL PANEL
DCS	DISTRIBUTED CONTROL SYSTEM	PFR	PHASEPOWER FAILURE RELAY
DI	DISCRETE INPUT	PI	PULSE INPUT
DO	DISCRETE OUTPUT	PLC	PROGRAMMABLE LOGIC CONTROLLER
DI/DT	DIFFERENTIAL VOLTAGE/TIME		
DWG	DRAWING	PLI	PLANT INFLUENT
		PKG	PACKAGE
ELR	END OF LINE RESISTER	PMP	PUMP
ETM	ELAPSED TIME METER	PNL	PANEL
EOL	ELECTRONIC OVERLOAD	PO	PULSE OUTPUT
ES	EMERGENCY STOP	PPG	POUNDS PER GALLON
EXIST	EXISTING	PPH	POUNDS PER HOUR
		PPM	PARTS PER MILLION
FA	FOUL AIR	PR	PAIR
FC	FAIL CLOSED	PRES	PRESSURE
FE	FLOW ELEMENT	PS	PRESSURE SWITCH
FLA	FULL LOAD AMPS	PSH	PRESSURE SWITCH, HIGH
FS	FLOW SWITCH	PSI	POUNDS PER SQUARE INCH
FVNR	FULL VOLTAGE NON-REVERSING	PV	PROCESS VARIABLE
FW	FINISHED WATER		
		RAS	RETURN ACTIVATED SLUDGE
G	GROUND	RW	RAW WATER
GES	GROUNDING ELECTRODE SYSTEM	RCL	REMOTE I/O
GFCI	GROUND FAULT CIRCUIT INTERRUPTER	RF	RADIO FREQUENCY
		RIO	REMOTE INPUT/OUTPUT
GFP	GROUND FAULT PROTECTION	RS	RAW SEWAGE
GND	GROUND	RSP	RAW SEWAGE PUMP
GPD	GALLONS PER DAY	RST	RESET
GPH	GALLONS PER HOUR	RTD	RESISTANCE TEMPERATURE DETECTOR
GPM	GALLONS PER MINUTE		
GRS	GALVANIZED RIGID STEEL	RTU	REMOTE TELEMETRY UNIT
		RWT	REFLECTED WAVE TRAP
H, HI	HIGH		
H2S	HYDROGEN SULFIDE	SEQ	SERVICE ENTRANCE EQUIPMENT
HMI	HUMAN MACHINE INTERFACE	SES	SERVICE ENTRANCE SECTION
HOA	HAND-OFF-AUTO	SLC	SINGLE LOOP CONTROLLER
HOR	HAND-OFF-REMOTE	SLOS	START-LOCK-OFF-STOP
		SMC	SUBMERSIBLE MANUFACTURER CABLE
I	CURRENT		
IC	INSTRUMENTATION CABLE	SO2	SULFUR DIOXIDE
ICR	INTERMITTENT CYCLE REACTOR	SP	SET POINT
IO	INPUT/OUTPUT	SPC	SPARE CONDUIT
ISC	SHORT CIRCUIT CURRENT	SPR	SPARE
ISR	INTRINSICALLY SAFE RELAY	SS	START/STOP
		SSS	SOLID STATE STARTER (SOFT START)
JB	JUNCTION BOX		
		ST	SHUNT TRIP
L, LO	LOW		
LAN	LOCAL AREA NETWORK	TC	TELEPHONE CABLE
LC	LOOP CONTROLLER	TDOE	TIME DELAY ON ENERGIZE
LCL	LEVEL CONTROL, LOW	TS	TEMPERATURE SWITCH
LCP	LOCAL CONTROL PANEL	TSP	TWISTED SHIELDED PAIR
LOS	LOCK-OUT-STOP	TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSION
LR	LOCAL/REMOTE		
LS	LEVEL SWITCH	TYP	TYPICAL
LTC	LIQUID TIGHT FLEXIBLE CONDUIT		
		UG	UNDERGROUND
M	MOTOR		
MA	MANUAL/AUTO, MILLIAMP	V	VOLT
MAX	MAXIMUM	VFD	VARIABLE FREQUENCY DRIVE
MC	MANUFACTURER'S CABLE		
MCB	MAIN CIRCUIT BREAKER	W	WATT, WIRE
MCC	MOTOR CONTROL CENTER	WAS	WASTE ACTIVATED SLUDGE
MCP	MOTOR CIRCUIT PROTECTOR	WP	WEATHERPROOF
MFR(S)	MANUFACTURER(S)		
MGD	MILLION GALLONS PER DAY	XFMR	TRANSFORMER
MGL	MILLIGRAMS PER LITER	XMTR	TRANSMITTER
MH	MANHOLE		
MIN	MINIMUM	ZS	POSITION SWITCH
ML	MIXED LIQUOR		
MOV	MOTOR OPERATED VALVE		
MTU	MASTER TELEMETRY UNIT		

ELECTRICAL LINETYPES

SYMBOL	DESCRIPTION
	EXPOSED CONDUIT
	UNDERGROUND CONDUIT
	BARE COPPER GROUND CONDUCTOR
	EXISTING EXPOSED CONDUIT
	EXISTING UNDERGROUND CONDUIT
	CAPPED UNDERGROUND CONDUIT OR STUBBUP
	NEW ELECTRICAL EQUIPMENT
	DETAIL VIEW OR MATCHING
	FUTURE
	CONDUIT DROP
	CONDUIT RISE

HEATH Engineering Company

STAMP

PROFESSIONAL ENGINEER 328126 NOLAN E. JOHNSON STATE OF UTAH 9/19/23

REVISIONS:	

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS
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CONSTRUCTION DOCUMENTS

SHEET DESCRIPTION: ELECTRICAL SYMBOL LEGEND

SHEET NUMBER: **E-001**

11/14/2023 9:39 AM - I:\22099\01 - DWG\ELEC\SHEET\22099-E-001.DWG - KINKADE MINSON

(E) PANEL DP-1111

MAIN BREAKER AMPS 150 — BUS AMPS: 225

VOLTAGE: 480/277 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 65 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: CHEMICAL AREA

BRANCH CIRCUIT BREAKER				CONNECTION	DESCRIPTION	PHASE			DESCRIPTION	CONNECTION	BRANCH CIRCUIT BREAKER				
NOTES	#	AMP	P.	LOAD (VA)		A	B	C		LOAD (VA)	P.	AMP	#	NOTES
3	DP-1111-1	60	3	14550	AHU-9510	23408			VCP-1800	8858	3	50	DP-1111-2	3
	DP-1111-3	--	--	14550	-------		23408		-------	8858	--	--	DP-1111-4	
	DP-1111-5	--	--	14550	-------			23408	-------	8858	--	--	DP-1111-6	
3	DP-1111-7	20	3	1663	VCP-20	10521			VCP-1900	8858	3	50	DP-1111-8	3
	DP-1111-9	--	--	1663	------		10521		-------	8858	--	--	DP-1111-10	
	DP-1111-11	--	--	1663	------			10521	-------	8858	--	--	DP-1111-12	
2	DP-1111-13	**20**	**3**		**SPARE**	0			**SPARE**		**3**	**20**	DP-1111-14	**1**
	DP-1111-15	**-**	**-**		**—**		0		**—**		**-**	**-**	DP-1111-16	
	DP-1111-17	**-**	**-**		**—**			0	**—**		**-**	**-**	DP-1111-18	
	DP-1111-19	20	3		SPARE	0			SPARE		3	20	DP-1111-20	
	DP-1111-21	--	--		-------		0		-------		--	--	DP-1111-22	
	DP-1111-23	--	--		-------			0	-------		--	--	DP-1111-24	
	DP-1111-25	20	3		SPARE	0			SPARE		3	20	DP-1111-26	
	DP-1111-27	--	--		-------		0		-------		--	--	DP-1111-28	
	DP-1111-29	--	--		-------			0	-------		--	--	DP-1111-30	
	DP-1111-31	20	3		SPARE	0			SPARE		3	20	DP-1111-32	
	DP-1111-33	--	--		-------		0		-------		--	--	DP-1111-34	
	DP-1111-35	--	--		-------			0	-------		--	--	DP-1111-36	
	DP-1111-37	20	3		SPARE				SPARE		3	20	DP-1111-38	
	DP-1111-39	--	--		-------				-------		--	--	DP-1111-40	
	DP-1111-41	--	--		-------				-------		--	--	DP-1111-42	
					PHASE SUBTOTALS (VA)	33929	33929	33929						
					PHASE TOTALS (KVA)	33.9	33.9	33.9						
					PHASE TOTALS @ 277V (AMPS)	122.5	122.5	122.5						

NOTES:
1. EXISTING BREAKER TO BE REMOVED AND REPLACED WITH NEW. SEE REMODEL PANEL SCHEDULE
2. NEW EQUIPMENT LOAD CONNECTED TO SPARE BREAKER
3. EXISTING LOAD TO REMAIN
4.

REMODEL PANEL DP-1111

MAIN BREAKER AMPS 150 — BUS AMPS: 225

VOLTAGE: 480/277 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 65 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: CHEMICAL AREA

BRANCH CIRCUIT BREAKER				CONNECTION	DESCRIPTION	PHASE			DESCRIPTION	CONNECTION	BRANCH CIRCUIT BREAKER				
NOTES	#	AMP	P.	LOAD (VA)		A	B	C		LOAD (VA)	P.	AMP	#	NOTES
1	DP-1111-1	60	3	14550	AHU-9510	23408			VCP-1800	8858	3	50	DP-1111-2	1
	DP-1111-3	--	--	14550	-------		23408		-------	8858	--	--	DP-1111-4	
	DP-1111-5	--	--	14550	-------			23408	-------	8858	--	--	DP-1111-6	
1	DP-1111-7	20	3	1663	VCP-20	10521			VCP-1900	8858	3	50	DP-1111-8	1
	DP-1111-9	--	--	1663	------		10521		-------	8858	--	--	DP-1111-10	
	DP-1111-11	--	--	1663	------			10521	-------	8858	--	--	DP-1111-12	
2	DP-1111-13	20	3	**2760**	**EHC-1**	11624			**HP-5**	**8864**	**3**	**50**	DP-1111-14	**3**
	DP-1111-15	--	--	**2760**	**—**		11624		**—**	**8864**	**-**	**-**	DP-1111-16	
	DP-1111-17	--	--	**2760**	**—**			11624	**—**	**8864**	**-**	**-**	DP-1111-18	
	DP-1111-19	20	3		SPARE	0			SPARE		3	20	DP-1111-20	
	DP-1111-21	--	--		-------		0		-------		--	--	DP-1111-22	
	DP-1111-23	--	--		-------			0	-------		--	--	DP-1111-24	
	DP-1111-25	20	3		SPARE	0			SPARE		3	20	DP-1111-26	
	DP-1111-27	--	--		-------		0		-------		--	--	DP-1111-28	
	DP-1111-29	--	--		-------			0	-------		--	--	DP-1111-30	
	DP-1111-31	20	3		SPARE	0			SPARE		3	20	DP-1111-32	
	DP-1111-33	--	--		-------		0		-------		--	--	DP-1111-34	
	DP-1111-35	--	--		-------			0	-------		--	--	DP-1111-36	
	DP-1111-37	20	3		SPARE				SPARE		3	20	DP-1111-38	
	DP-1111-39	--	--		-------				-------		--	--	DP-1111-40	
	DP-1111-41	--	--		-------				-------		--	--	DP-1111-42	
					PHASE SUBTOTALS (VA)	45553	45553	45553						
					PHASE TOTALS (KVA)	45.6	45.6	45.6						
					PHASE TOTALS @ 277V (AMPS)	164.5	164.5	164.5						

NOTES:
1. EXISTING LOAD TO REAMAIN
2. NEW EQUIPMENT LOAD CONNECTED TO SPARE BREAKER
3. PROVIDE NEW BREAKER FOR NEW EQUIPMENT LOAD.
4. PROVIDE CORRECTED AND UPDATED TYPE WRITTEN PANEL SCHEDULE.

(E) PANEL EC-LA

MLO — BUS AMPS: 225

VOLTAGE: 208/120 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 22 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: ELECTRICAL ROOM 123

BRANCH CIRCUIT BREAKER				CONNECTION	DESCRIPTION	PHASE			DESCRIPTION	CONNECTION	BRANCH CIRCUIT BREAKER			
NOTES	#	AMP	P.	LOAD (VA)		A	B	C		LOAD (VA)	P.	AMP	#	NOTES
	EC-LA-1	20	1	800	MEETING 125	1600			MEETING 124	800	1	20	EC-LA-2	
	EC-LA-3	20	1	800	MEETING 124		1400		RECEPTION	600	1	20	EC-LA-4	
	EC-LA-5	20	1	400	ENTRY 101 FB			600	RECEPTION FURNITURE	200	1	20	EC-LA-6	
	EC-LA-7	20	1	1000	ELECTRIC 123	2200			ENTRY 101 DISPLAY	1200	1	20	EC-LA-8	
	EC-LA-9	20	1	800	MEETING 124 FB		1200		MAIN HALL FB	400	1	20	EC-LA-10	
	EC-LA-11	20	1	400	MAIN HALL FB			800	MAIN HALL FB	400	1	20	EC-LA-12	
	EC-LA-13	20	1	400	MAIN HALL FB	800			MAIN HALL FB	400	1	20	EC-LA-14	
	EC-LA-15	20	1	1000	MAIN HALL		1800		MAIN HALL WB	800	1	20	EC-LA-16	
	EC-LA-17	20	1	800	MEETING 126 FB			1600	MEETING 126 FB	800	1	20	EC-LA-18	
	EC-LA-19	20	1	800	MEETING 125 FB	1600			MEETING 125 FB	800	1	20	EC-LA-20	
	EC-LA-21	20	1	800	MEETING 124 FB		1600		WINDOW SHADES	800	1	20	EC-LA-22	
	EC-LA-23	20	1	800	DATA 117			1000	MEETING 125 FB	800	1	20	EC-LA-24	
	EC-LA-25	20	1	800	MEETING 126 FB	1600			MEETING 126 FB	800	1	20	EC-LA-26	
	EC-LA-27	20	1	800	MEETING 124		2000		MEETING 124, 125, 126 WB	1200	1	20	EC-LA-28	
	EC-LA-29	20	1	600	HALL 113			1800	DRINKING FOUNTAIN	1200	1	20	EC-LA-30	
	EC-LA-31	20	1	200	JANITOR 116	600			MEN 114, WOMEN 115	400	1	20	EC-LA-32	
	EC-LA-33	20	1	200	MECHANICAL 119		600		GREENHOUSE 120	400	1	20	EC-LA-34	
	EC-LA-35	20	1	400	GREENHOUSE 120			800	ELECTRICAL 123	400	1	20	EC-LA-36	
	EC-LA-37	20	1	200	KITCHEN COUNTER	1400			KITCHEN REF	1200	1	20	EC-LA-38	
	EC-LA-39	20	1	600	KITCHEN COUNTER		1800		KITCHEN DISPOSER	1200	1	20	EC-LA-40	
	EC-LA-41	50	3	1200	RANGE			1800	WINDOW SHADES 124, 125	600	1	20	EC-LA-42	
	EC-LA-43	--	--	1200	-------	2200			KITCHEN HOOD	1000	1	20	EC-LA-44	
	EC-LA-45	--	--	1200	-------		1600		CON-I GREENHOUSE	400	1	20	EC-LA-46	
	EC-LA-47	20	3	400	LIGHT POLE OUTLETS			1000	PLAZZA POLE OUTLETS	600	3	20	EC-LA-48	
	EC-LA-49	--	--	400	-------	1200			-------	800	--	--	EC-LA-50	
	EC-LA-51	--	--	600	-------		1400		-------	800	--	--	EC-LA-52	
	EC-LA-53	20	3	400	LIGHT POLE OUTLETS			800	ENTRY POLE OUTLETS	400	1	20	EC-LA-54	
	EC-LA-55	--	--	400	----------	800			ENTRY POLE OUTLETS	400	1	20	EC-LA-56	
	EC-LA-57	--	--	600	----------		800		GENERATOR OUTLET	200	1	20	EC-LA-58	
	EC-LA-59	20	1	300	WINDOWS SHADES EAST			500	GATE MOTOR	200	3	20	EC-LA-60	
	EC-LA-61	20	1		SPARE	200			-------	200	--	--	EC-LA-62	
	EC-LA-63	20	1		SPARE		200		-------	200	--	--	EC-LA-64	
	EC-LA-65	20	1		SPARE			0	SPARE		1	20	EC-LA-66	
	EC-LA-67	20	1		SPARE	400			EXISTING LOAD	400	1	20	EC-LA-68	1, 2
	EC-LA-69	20	1		PROVISION		0		PROVISION		1	20	EC-LA-70	
	EC-LA-71	20	1		PROVISION			0	PROVISION		1	20	EC-LA-72	
	EC-LA-73	20	1		PROVISION	0			PROVISION		1	20	EC-LA-74	
	EC-LA-75	20	1		PROVISION		0		PROVISION		1	20	EC-LA-76	
	EC-LA-77	20	1		PROVISION			0	PROVISION		1	20	EC-LA-78	
	EC-LA-79	20	1		PROVISION	0			PROVISION		1	20	EC-LA-80	
	EC-LA-81	20	1		PROVISION		0		PROVISION		1	20	EC-LA-82	
	EC-LA-83	20	1		PROVISION			0	PROVISION		1	20	EC-LA-84	
					PHASE SUBTOTALS (VA)	14600	14400	10700						
					PHASE TOTALS (KVA)	14.6	14.4	10.7						
					PHASE TOTALS @ 120V (AMPS)	121.7	120.0	89.2						

NOTES:
1. EXISTING BREAKER TO BE REMOVED AND REPLACED WITH NEW. SEE REMODEL PANEL SCHEDULE
2. EXISTING LOAD TO BE RELOCATED TO CIRCUIT 72. SEE REMODEL PANEL SCHEDULE.
3. FIELD VERIFY EXISTING PANEL SCHEDULE AND LOADS.
4.

REMODEL PANEL EC-LA

MLO — BUS AMPS: 225

VOLTAGE: 208/120 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 22 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: ELECTRICAL ROOM 123

BRANCH CIRCUIT BREAKER				CONNECTION	DESCRIPTION	PHASE			DESCRIPTION	CONNECTION	BRANCH CIRCUIT BREAKER			
NOTES	#	AMP	P.	LOAD (VA)		A	B	C		LOAD (VA)	P.	AMP	#	NOTES
	EC-LA-1	20	1	800	MEETING 125	1600			MEETING 124	800	1	20	EC-LA-2	
	EC-LA-3	20	1	800	MEETING 124		1400		RECEPTION	600	1	20	EC-LA-4	
	EC-LA-5	20	1	400	ENTRY 101 FB			600	RECEPTION FURNITURE	200	1	20	EC-LA-6	
	EC-LA-7	20	1	1000	ELECTRIC 123	2200			ENTRY 101 DISPLAY	1200	1	20	EC-LA-8	
	EC-LA-9	20	1	800	MEETING 124 FB		1200		MAIN HALL FB	400	1	20	EC-LA-10	
	EC-LA-11	20	1	400	MAIN HALL FB			800	MAIN HALL FB	400	1	20	EC-LA-12	
	EC-LA-13	20	1	400	MAIN HALL FB	800			MAIN HALL FB	400	1	20	EC-LA-14	
	EC-LA-15	20	1	1000	MAIN HALL		1800		MAIN HALL WB	800	1	20	EC-LA-16	
	EC-LA-17	20	1	800	MEETING 126 FB			1600	MEETING 126 FB	800	1	20	EC-LA-18	
	EC-LA-19	20	1	800	MEETING 125 FB	1600			MEETING 125 FB	800	1	20	EC-LA-20	
	EC-LA-21	20	1	800	MEETING 124 FB		1600		WINDOW SHADES	800	1	20	EC-LA-22	
	EC-LA-23	20	1	200	DATA 117			1000	MEETING 125 FB	800	1	20	EC-LA-24	
	EC-LA-25	20	1	800	MEETING 126 FB	1600			MEETING 126 FB	800	1	20	EC-LA-26	
	EC-LA-27	20	1	800	MEETING 124		2000		MEETING 124, 125, 126 WB	1200	1	20	EC-LA-28	
	EC-LA-29	20	1	600	HALL 113			1800	DRINKING FOUNTAIN	1200	1	20	EC-LA-30	
	EC-LA-31	20	1	200	JANITOR 116	600			MEN 114, WOMEN 115	400	1	20	EC-LA-32	
	EC-LA-33	20	1	200	MECHANICAL 119		600		GREENHOUSE 120	400	1	20	EC-LA-34	
	EC-LA-35	20	1	400	GREENHOUSE 120			800	ELECTRICAL 123	400	1	20	EC-LA-36	
	EC-LA-37	20	1	200	KITCHEN COUNTER	1400			KITCHEN REF	1200	1	20	EC-LA-38	
	EC-LA-39	20	1	600	KITCHEN COUNTER		1800		KITCHEN DISPOSER	1200	1	20	EC-LA-40	
	EC-LA-41	50	3	1200	RANGE			1800	WINDOW SHADES 124, 125	600	1	20	EC-LA-42	
	EC-LA-43	--	--	1200	-------	2200			KITCHEN HOOD	1000	1	20	EC-LA-44	
	EC-LA-45	--	--	1200	-------		1600		CON-I GREENHOUSE	400	1	20	EC-LA-46	
	EC-LA-47	20	3	400	LIGHT POLE OUTLETS			1000	PLAZZA POLE OUTLETS	600	3	20	EC-LA-48	
	EC-LA-49	--	--	400	-------	1200			-------	800	--	--	EC-LA-50	
	EC-LA-51	--	--	600	-------		1400		-------	800	--	--	EC-LA-52	
	EC-LA-53	20	3	400	LIGHT POLE OUTLETS			800	ENTRY POLE OUTLETS	400	1	20	EC-LA-54	
	EC-LA-55	--	--	400	----------	800			ENTRY POLE OUTLETS	400	1	20	EC-LA-56	
	EC-LA-57	--	--	600	----------		800		GENERATOR OUTLET	200	1	20	EC-LA-58	
	EC-LA-59	20	1	300	WINDOWS SHADES EAST			500	GATE MOTOR	200	3	20	EC-LA-60	
	EC-LA-61	20	1		SPARE	200			-------	200	--	--	EC-LA-62	
	EC-LA-63	20	1		SPARE		200		-------	200	--	--	EC-LA-64	
	EC-LA-65	20	1		SPARE			4224	**HP-3**	**4224**	**3**	**70**	**EC-LA-66**	**1**
	EC-LA-67	20	1		SPARE	4224			**—**	**4224**	**-**	**-**	**EC-LA-68**	
	EC-LA-69	20	1		PROVISION		4224		**—**	**4224**	**-**	**-**	**EC-LA-70**	
	EC-LA-71	20	1		PROVISION			400	**EXISTING LOAD**	**400**	**1**	**20**	**EC-LA-72**	**2**
	EC-LA-73	20	1		PROVISION	0			PROVISION		1	20	EC-LA-74	
	EC-LA-75	20	1		PROVISION		0		PROVISION		1	20	EC-LA-76	
	EC-LA-77	20	1		PROVISION			0	PROVISION		1	20	EC-LA-78	
	EC-LA-79	20	1		PROVISION	0			PROVISION		1	20	EC-LA-80	
	EC-LA-81	20	1		PROVISION		0		PROVISION		1	20	EC-LA-82	
	EC-LA-83	20	1		PROVISION			0	PROVISION		1	20	EC-LA-84	
					PHASE SUBTOTALS (VA)	18424	16624	15324						
					PHASE TOTALS (KVA)	18.4	16.6	15.3						
					PHASE TOTALS @ 120V (AMPS)	153.5	155.2	127.7						

NOTES:
1. PROVIDE NEW BREAKER FOR NEW LOAD
2. RELOCATED LOAD
3. PROVIDE CORRECTED AND UPDATED TYPE WRITTEN PANEL SCHEDULE.
4.

HEATH
Engineering Company

STAMP

PROFESSIONAL ENGINEER
328126
NOLAN E. JOHNSON
STATE OF UTAH

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

HEATH PROJECT No:	22099
CHECKED BY:	**NEJ**
DRAWN BY:	**KJB**
DATE:	November 14, 2023

CONSTRUCTION DOCUMENTS

SHEET DESCRIPTION
SWGWTP AND EDUCATION CENTER
ELECTRICAL PANEL SCHEDULES

SHEET NUMBER
E-002

(E) PANEL EC-LM (SEC 1)

MLO — BUS AMPS: 400

VOLTAGE: 208/120 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 22 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: MECHANICAL ROOM 119

BRANCH CIRCUIT BREAKER NOTES	#	AMP	P.	CONNECTION LOAD (VA)	DESCRIPTION	PHASE A	PHASE B	PHASE C	DESCRIPTION	CONNECTION LOAD (VA)	BRANCH CIRCUIT BREAKER P.	AMP	#	NOTES
2	EC-LM-1	20	2	1400	RMU-1, RMU-2	2000			FC-9, FC-10	600	2	20	EC-LM-2	2
	EC-LM-3	--	--	1400	--------		2000		--------	600	--	--	EC-LM-4	
2	EC-LM-5	20	2	500	FC-1A, FC-12			1100	FC1D, FC2, FC-3, FC-4	600	2	20	EC-LM-6	2
	EC-LM-7	--	--	500	--------	1100			--------	600	--	--	EC-LM-8	
2	EC-LM-9	20	2	500	FC-1B, FC-13		700		JUNCTION BOX RM 106	200	1	20	EC-LM-10	2
	EC-LM-11	--	--	500	--------			500	SPARE		2	20	EC-LM-12	
2	EC-LM-13	20	2	600	FC-1C, FC-14	600			--------		--	--	EC-LM-14	
	EC-LM-15	--	--	600	--------		1200		EF-2	600	1	20	EC-LM-16	2
2	EC-LM-17	20	2	500	FC-5, FC-6, FC-7, FC-8			700	MECHANICAL OUTLET	200	1	20	EC-LM-18	2
	EC-LM-19	--	--	500	--------	500			SPARE		2	20	EC-LM-20	
2	EC-LM-21	40	2	2300	WH-1		2300		--------		--	--	EC-LM-22	
	EC-LM-23	--	--	2300	--------			3300	RMU-3, FC-11	1000	2	20	EC-LM-24	2
1	EC-LM-25	**40**	**2**	**2600**	**COMPRESSOR UNIT 2**	3600			--------	1000	--	--	EC-LM-26	
	EC-LM-27	**--**	**--**	**2600**	**——**		3200		EF-1	600	1	20	EC-LM-28	2
	EC-LM-29	**--**	**--**	**2600**	**——**			2600	SPARE		1	20	EC-LM-30	
1	EC-LM-31	**40**	**3**	**2600**	**COMPRESSOR UNIT 3**	2600			GLYCOL PUMP		1	20	EC-LM-32	
	EC-LM-33	**--**	**--**	**2600**	**——**		2600		S. WALL		1	20	EC-LM-34	
	EC-LM-35	**--**	**--**	**2600**	**——**			5600	COMPRESSOR UNIT 1	3000	3	40	EC-LM-36	2
2	EC-LM-37	50	3	3200	EVR-1	6200			--------	3000	--	--	EC-LM-38	
	EC-LM-39	--	--	3200	--------		6200		--------	3000	--	--	EC-LM-40	
	EC-LM-41	--	--	3200	--------			3200	SPARE		1	20	EC-LM-42	
					PHASE SUBTOTALS (VA)	16600	16200	17000						
					PHASE TOTALS (KVA)	16.6	18.2	17.0						
					PHASE TOTALS @ 120V (AMPS)	138.3	151.7	141.7						

NOTES:
1. EXISTING BREAKER TO BE REMOVED AND REPLACED WITH NEW. EXISTING BREAKERS AND LOADS MAY NEED TO BE RE-ARRANGED TO ACCOMMODATE NEW. SEE REMODEL PANEL SCHEDULE.
2. EXISTING LOAD TO REMAIN
3.
4.

(E) PANEL EC-LM (SEC 2)

MLO — BUS AMPS: 400

VOLTAGE: 208/120 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 22 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: MECHANICAL ROOM 119

BRANCH CIRCUIT BREAKER NOTES	#	AMP	P.	CONNECTION LOAD (VA)	DESCRIPTION	PHASE A	PHASE B	PHASE C	DESCRIPTION	CONNECTION LOAD (VA)	BRANCH CIRCUIT BREAKER P.	AMP	#	NOTES
2	EC-LM-43	20	3	200	RV-1	1400			HAF-1, HAF-1	1200	1	20	EC-LM-44	2
	EC-LM-45	--	--	200	----------		1400		SPARE	1200	1	20	EC-LM-46	2
	EC-LM-47	--	--	200	----------			800	MEF-1	600	1	20	EC-LM-48	2
	EC-LM-49	20	1			600			MEF-2	600	1	20	EC-LM-50	2
2	EC-LM-51	40	3	1300	P-2		1900		MEF-3	600	1	20	EC-LM-52	2
	EC-LM-53	--	--	1300	--------			1900	MEF-4	600	1	20	EC-LM-54	2
	EC-LM-55	--	--	1300	--------	1500			SV-1	200	2	20	EC-LM-56	2
2	EC-LM-57	20	1	900	P-3		1100		--------	200	--	--	EC-LM-58	
2	EC-LM-59	20	1	600	P-4			600	HEAT PUMP		2	20	EC-LM-60	
2	EC-LM-61	20	1	1200	P-5	1200			----------		--	--	EC-LM-62	
2	EC-LM-63	20	1	1200	P-6		1200		**?**		**1**	**20**	EC-LM-64	**1**
1	EC-LM-65	**20**	**1**		**SPARE**			0	**SPARE**		**1**	**20**	EC-LM-66	
1	EC-LM-67	**20**	**2**		**SPARE**	0			**?**		**1**	**20**	EC-LM-68	
	EC-LM-69	**--**	**--**		**——**		1200		P-1	1200	3	30	EC-LM-70	2
	EC-LM-71	20	2		SPARE			1200	--------	1200	--	--	EC-LM-72	
	EC-LM-73	--	--		--------	1200			--------	1200	--	--	EC-LM-74	
	EC-LM-75	20	1		SPARE		0		SPARE		1	20	EC-LM-76	
	EC-LM-77	20	1		SPARE			0	SPARE		1	20	EC-LM-78	
2	EC-LM-79	20	1	200	MECHANICAL CONTROLS	200			WATER SOURCE HEAT PUMP		3	50	EC-LM-80	
2	EC-LM-81	20	1	200	MECHANICAL CONTROLS		200		--------		--	--	EC-LM-82	
2	EC-LM-83	20	1	200	MECHANICAL CONTROLS			200	--------		--	--	EC-LM-84	
					PHASE SUBTOTALS (VA)	6100	7000	4700						
					PHASE TOTALS (KVA)	6.1	7.0	4.7						
					PHASE TOTALS @ 120V (AMPS)	50.8	58.3	39.2						

NOTES:
1. EXISTING BREAKER TO BE REMOVED AND REPLACED WITH NEW. EXISTING BREAKERS AND LOADS MAY NEED TO BE RE-ARRANGED TO ACCOMMODATE NEW. SEE REMODEL PANEL SCHEDULE
2. EXISTING LOAD TO REMAIN
3.
4.

REMDL PANEL EC-LM (SEC 1)

MLO — BUS AMPS: 400

VOLTAGE: 208/120 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 22 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: MECHANICAL ROOM 119

BRANCH CIRCUIT BREAKER NOTES	#	AMP	P.	CONNECTION LOAD (VA)	DESCRIPTION	PHASE A	PHASE B	PHASE C	DESCRIPTION	CONNECTION LOAD (VA)	BRANCH CIRCUIT BREAKER P.	AMP	#	NOTES
	EC-LM-1	20	2	1400	RMU-1, RMU-2	2000			FC-9, FC-10	600	2	20	EC-LM-2	
	EC-LM-3	--	--	1400	--------		2000		--------	600	--	--	EC-LM-4	
	EC-LM-5	20	2	500	FC-1A, FC-12			1100	FC1D, FC2, FC-3, FC-4	600	2	20	EC-LM-6	
	EC-LM-7	--	--	500	--------	1100			--------	600	--	--	EC-LM-8	
	EC-LM-9	20	2	500	FC-1B, FC-13		700		JUNCTION BOX RM 106	200	1	20	EC-LM-10	
	EC-LM-11	--	--	500	--------			500	SPARE		2	20	EC-LM-12	
	EC-LM-13	20	2	600	FC-1C, FC-14	600			--------		--	--	EC-LM-14	
	EC-LM-15	--	--	600	--------		1200		EF-2	600	1	20	EC-LM-16	
	EC-LM-17	20	2	500	FC-5, FC-6, FC-7, FC-8			700	MECHANICAL OUTLET	200	1	20	EC-LM-18	
	EC-LM-19	--	--	500	--------	500			SPARE		2	20	EC-LM-20	
	EC-LM-21	30	2	2300	WH-1		2300		--------		--	--	EC-LM-22	
	EC-LM-23	--	--	2300	--------			3300	RMU-3, FC-11	1000	2	20	EC-LM-24	
3	EC-LM-25	**70**	**2**	**4224**	**HP-1**	5224			--------	1000	--	--	EC-LM-26	
	EC-LM-27	**--**	**--**	**4224**	**——**		4824		EF-1	600	1	20	EC-LM-28	
	EC-LM-29	**--**	**--**	**4224**	**——**			4224	SPARE		1	20	EC-LM-30	
3	EC-LM-31	**70**	**3**	**4224**	**HP-2**	4224			SPARE		1	20	EC-LM-32	
	EC-LM-33	**--**	**--**	**4224**	**——**		4224		SPARE		1	20	EC-LM-34	
	EC-LM-35	**--**	**--**	**4224**	**——**			7224	WSHP-1	3000	3	50	EC-LM-36	
	EC-LM-37	50	3	3200	EVR-1	6200			--------	3000	--	--	EC-LM-38	
	EC-LM-39	--	--	3200	--------		6200		--------	3000	--	--	EC-LM-40	
	EC-LM-41	--	--	3200	--------			3200	SPARE		1	20	EC-LM-42	
					PHASE SUBTOTALS (VA)	19848	21448	20248						
					PHASE TOTALS (KVA)	19.8	21.4	20.2						
					PHASE TOTALS @ 120V (AMPS)	165.4	178.7	168.7						

NOTES:
1. EXISTING LOAD TO REAMAIN
2. NEW EQUIPMENT LOAD CONNECTED TO SPARE BREAKER.
3. PROVIDE NEW BREAKER FOR NEW EQUIPMENT LOAD. EXISTING BREAKERS AND LOADS MAY NEED TO BE RE-ARRANGED TO ACCOMMODATE NEW.
4. PROVIDE CORRECTED AND UPDATED TYPE WRITTEN PANEL SCHEDULE.

REMDL PANEL EC-LM (SEC 2)

MLO — BUS AMPS: 400

VOLTAGE: 208/120 V 3Ø 4W — CIRCUIT BREAKER TYPE: BOLT-ON — MOUNTING: SURFACE

ENCLOSURE: NEMA 1 — INTERRUPTING CAPACITY: 22 KAIC — COVER TYPE: DOOR-IN-DOOR

LOCATION: MECHANICAL ROOM 119

BRANCH CIRCUIT BREAKER NOTES	#	AMP	P.	CONNECTION LOAD (VA)	DESCRIPTION	PHASE A	PHASE B	PHASE C	DESCRIPTION	CONNECTION LOAD (VA)	BRANCH CIRCUIT BREAKER P.	AMP	#	NOTES
	EC-LM-43	20	2	200	RV-1	1400			HAF-1, HAF-1	1200	1	20	EC-LM-44	
	EC-LM-45	--	--	200	----------		1400		SM-1	1200	1	20	EC-LM-46	
	EC-LM-47	20	2		SPARE			600	MEF-1	600	1	20	EC-LM-48	
	EC-LM-49	--	--		--------	600			MEF-2	600	1	20	EC-LM-50	
	EC-LM-51	40	3	1300	P-2		1900		MEF-3	600	1	20	EC-LM-52	
	EC-LM-53	--	--	1300	--------			1900	MEF-4	600	1	20	EC-LM-54	
	EC-LM-55	--	--	1300	--------	1500			SV-1	200	2	20	EC-LM-56	
	EC-LM-57	20	1	900	P-3		1100		--------	200	--	--	EC-LM-58	
	EC-LM-59	20	1	600	P-4			600	SPARE		2	20	EC-LM-60	
	EC-LM-61	20	1	1200	P-5	1200			-----		--	--	EC-LM-62	
	EC-LM-63	20	1	1200	P-6		5107		**HP-4 (2)**	**3907**	**3**	**50**	EC-LM-64	3
3	EC-LM-65	**50**	**3**	**3907**	**HP-4 (1)**			7814	**——**	**3907**	**--**	**--**	EC-LM-66	
	EC-LM-67	**--**	**--**	**3907**	**——**	7814			**——**	**3907**	**--**	**--**	EC-LM-68	
	EC-LM-69	**--**	**--**	**3907**	**——**		5107		P-1	1200	3	30	EC-LM-70	
	EC-LM-71	20	2		SPARE			1200	--------	1200	--	--	EC-LM-72	
	EC-LM-73	--	--			1200			--------	1200	--	--	EC-LM-74	
	EC-LM-75	20	1		------		0		SPARE		1	20	EC-LM-76	
	EC-LM-77	20	1		SPARE			0	SPARE		1	20	EC-LM-78	
	EC-LM-79	20	1	200	MECHANICAL CONTROLS	200			SPARE		1	20	EC-LM-80	
	EC-LM-81	20	1	200	MECHANICAL CONTROLS		200		SPARE		1	20	EC-LM-82	
	EC-LM-83	20	1	200	MECHANICAL CONTROLS			200	SPARE		1	20	EC-LM-84	
					PHASE SUBTOTALS (VA)	13914	14814	12314						
					PHASE TOTALS (KVA)	13.9	14.8	12.3						
					PHASE TOTALS @ 120V (AMPS)	116.0	123.5	102.6						

NOTES:
1. EXISTING LOAD TO REAMAIN
2. NEW EQUIPMENT LOAD CONNECTED TO SPARE BREAKER.
3. PROVIDE NEW BREAKER FOR NEW EQUIPMENT LOAD. EXISTING BREAKERS AND LOADS MAY NEED TO BE RE-ARRANGED TO ACCOMMODATE NEW.
4. PROVIDE CORRECTED AND UPDATED TYPE WRITTEN PANEL SCHEDULE.

HEATH
Engineering Company

STAMP

PROFESSIONAL ENGINEER
328126
NOLAN E. JOHNSON
STATE OF UTAH

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

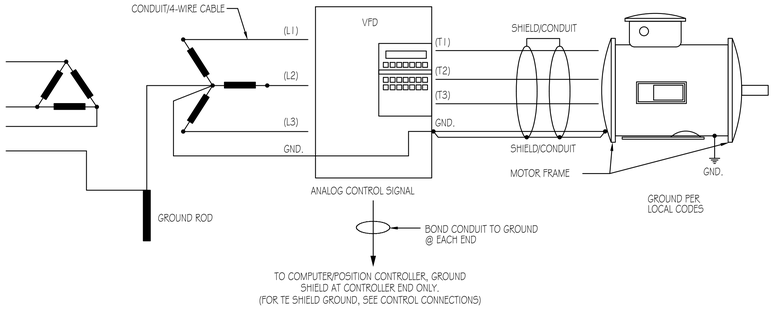
SHEET DESCRIPTION

EDUCATION CENTER

ELECTRICAL PANEL SCHEDULES

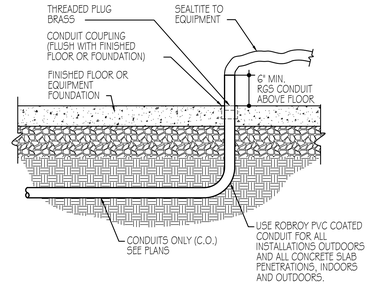
SHEET NUMBER

E-003



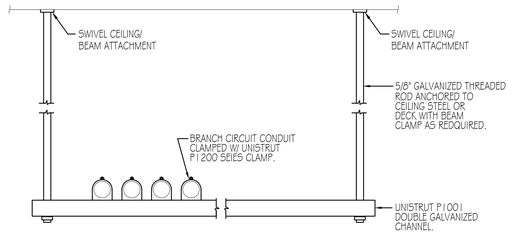
VFD GROUNDING DIAGRAM

5 / E-501 SCALE: NONE



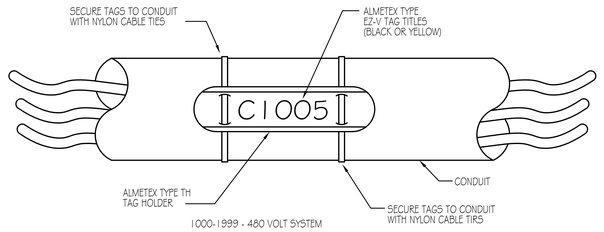
CONDUIT TERMINATION UNDER EQUIPMENT

6 / E-501 SCALE: NONE



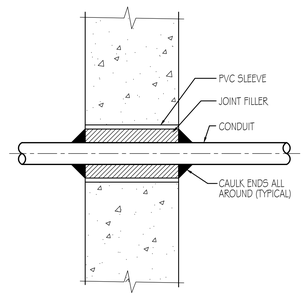
CONDUIT SUPPORT DETAIL

7 / E-501 SCALE: NONE



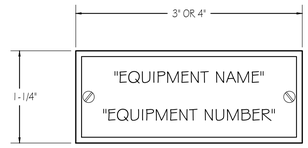
CONDUIT MARKING SYSTEM

8 / E-501 SCALE: NONE



CONDUIT PENETRATION AT NEW WALL OR SLAB

1 / E-501 SCALE: NONE

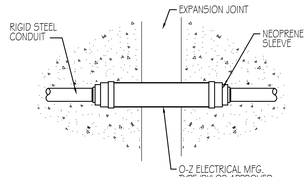


NOTES:

1. ALL LETTERS TO BE 1/4" UNLESS NOTED OTHERWISE.
2. ALL NAMEPLATES TO BE MOUNTED ON THE VERTICAL CENTERLINE OF THE CUBICAL OR DEVICE.
3. ATTACH ALL NAMEPLATES WITH STAINLESS STEEL SCREWS.
4. PROVIDE BLANK NAMEPLATES FOR ALL SPARE AND FUTURE DEVICES.

NAMEPLATE DETAIL

2 / E-501 SCALE: NONE

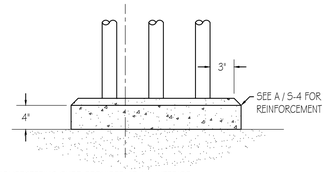


NOTE:

PROVIDE EXTERNAL BONDING JUMPER WHEN COUPLING HAS NO INTERIOR JUMPER.

EXPANSION COUPLING

3 / E-501 SCALE: NONE



HOUSEKEEPING CURB REQUIRED AT ALL INTERIOR WALL LOCATIONS FOR SINGLE AND MULTIPLE RISERS. RISERS SHALL BE COUPLED SO THAT SINGLE RISERS ARE SIX FEET APART MIN.

CONCRETE HOUSEKEEPING CURB DETAIL

4 / E-501 SCALE: NONE

HEATH Engineering Company

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PROFESSIONAL ENGINEER 328126 NOLAN E. JOHNSON STATE OF UTAH 9/9/23

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

SHEET DESCRIPTION

ELECTRICAL DETAILS

SHEET NUMBER

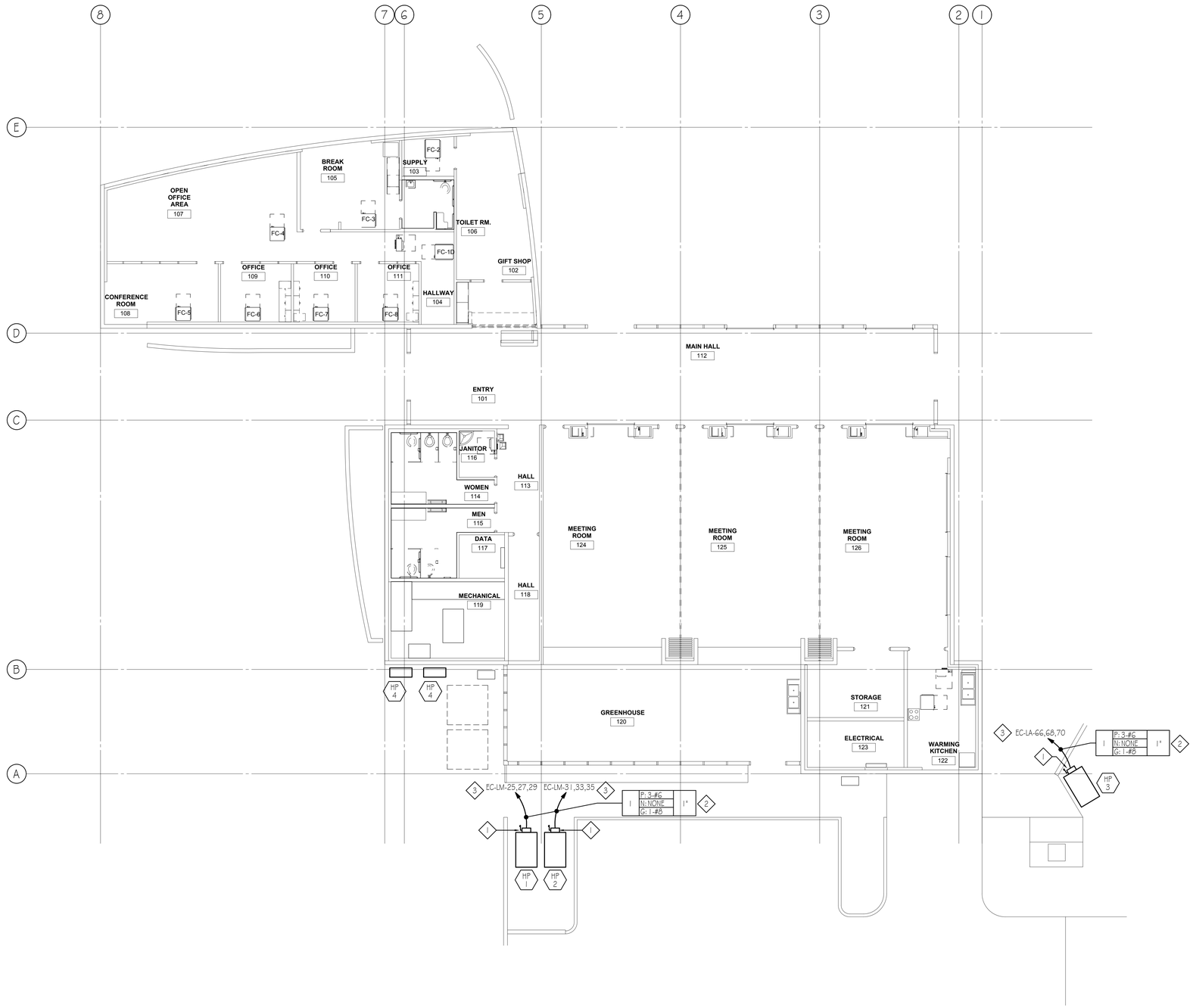
E-501

CONSTRUCTION DOCUMENTS

11/14/2023 9:40 AM - I:\22099\01 - DWG\ELEC\SHEET\22099-E-501.DWG - KINKADE MINSON

DRAWING NOTES

1. 60 / 3 / FUSE PER NAMEPLATE / 3R / 240 / HD
2. COORDINATE WITH MECHANICAL FOR CONDUIT LOCATION.
3. PROVIDE NEW BREAKER IN EXISTING PANEL. FIELD VERIFY PANEL SCHEDULE AND SPACE FOR NEW BREAKER. ADJUST AND REARRANGE EXISTING LOADS AND ASSOCIATED BREAKERS AS REQUIRED TO ACCOMMODATE NEW BREAKER LOCATIONS.



1 / E-101 EDUCATION CENTER POWER REMODEL PLAN

SCALE: 1/8" = 1'-0"

10 5 0 10 20

N

HEATH
Engineering Company

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PROFESSIONAL ENGINEER
328126
NOLAN E. JOHNSON
STATE OF UTAH
11/14/23

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

SHEET DESCRIPTION

EDUCATION CENTER

POWER
REMODEL PLAN

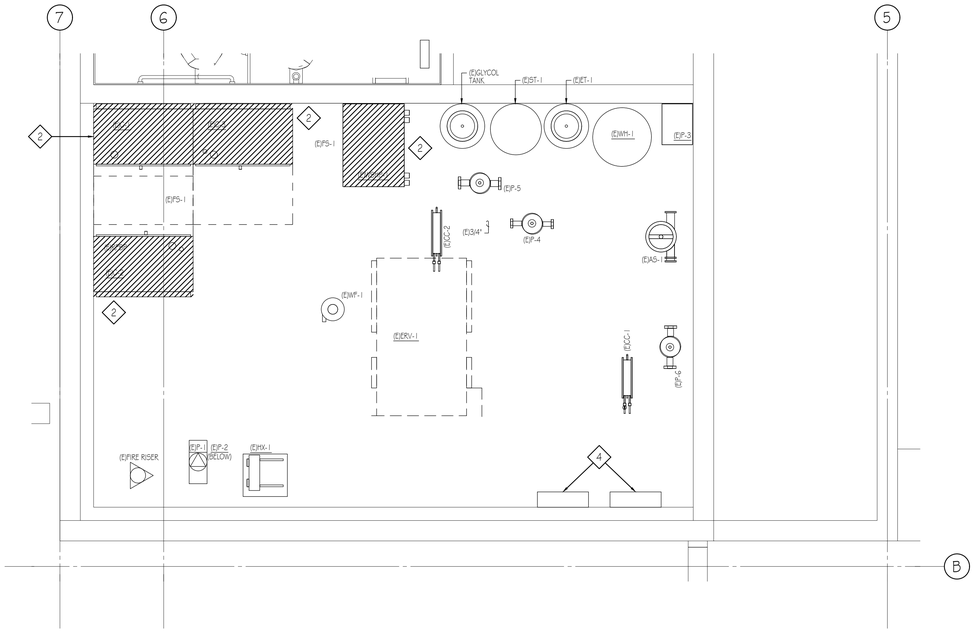
SHEET NUMBER

E-101

11/14/2023 9:40 AM - I:\22099\01 - DWG\ELEC\SHEET\22099-E-101.DWG - KINKADE MINSON

DRAWING NOTES

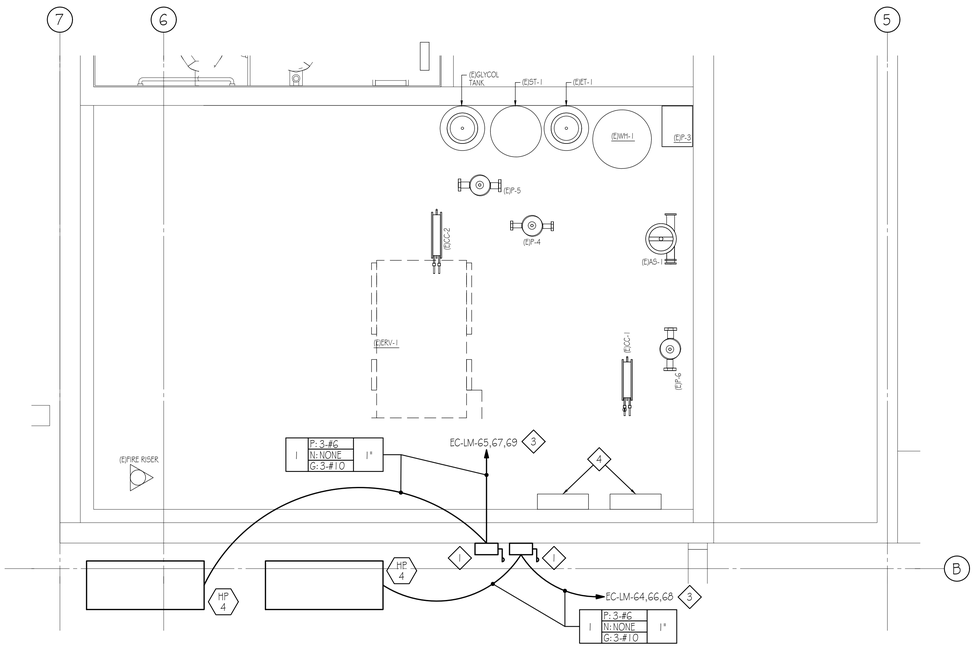
1. 60 / 3 / FUSE PER NAMEPLATE / 3R / 240 / HD
2. EXISTING MECHANICAL EQUIPMENT TO BE REMOVED. REMOVE ALL ASSOCIATED DISCONNECTS, CONTROLLERS, ACCESSIBLE CONDUIT AND WIRE BACK TO SOURCE.
3. PROVIDE NEW BREAKER IN EXISTING PANEL. FIELD VERIFY PANEL SCHEDULE AND SPACE FOR NEW BREAKER. ADJUST AND REARRANGE EXISTING LOADS AND ASSOCIATED BREAKERS AS REQUIRED TO ACCOMMODATE NEW BREAKER LOCATIONS.
4. EXISTING PANEL-EC LM SECTION 1 AND SECTION 2.



1 E-401 ENLARGED POWER DEMOLITION PLAN - EDUCATION CENTER

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

2 0 5



2 E-401 ENLARGED POWER REMODEL PLAN - EDUCATION CENTER

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

2 0 5

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STATE OF UTAH
9/8/23

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
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CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

SHEET DESCRIPTION

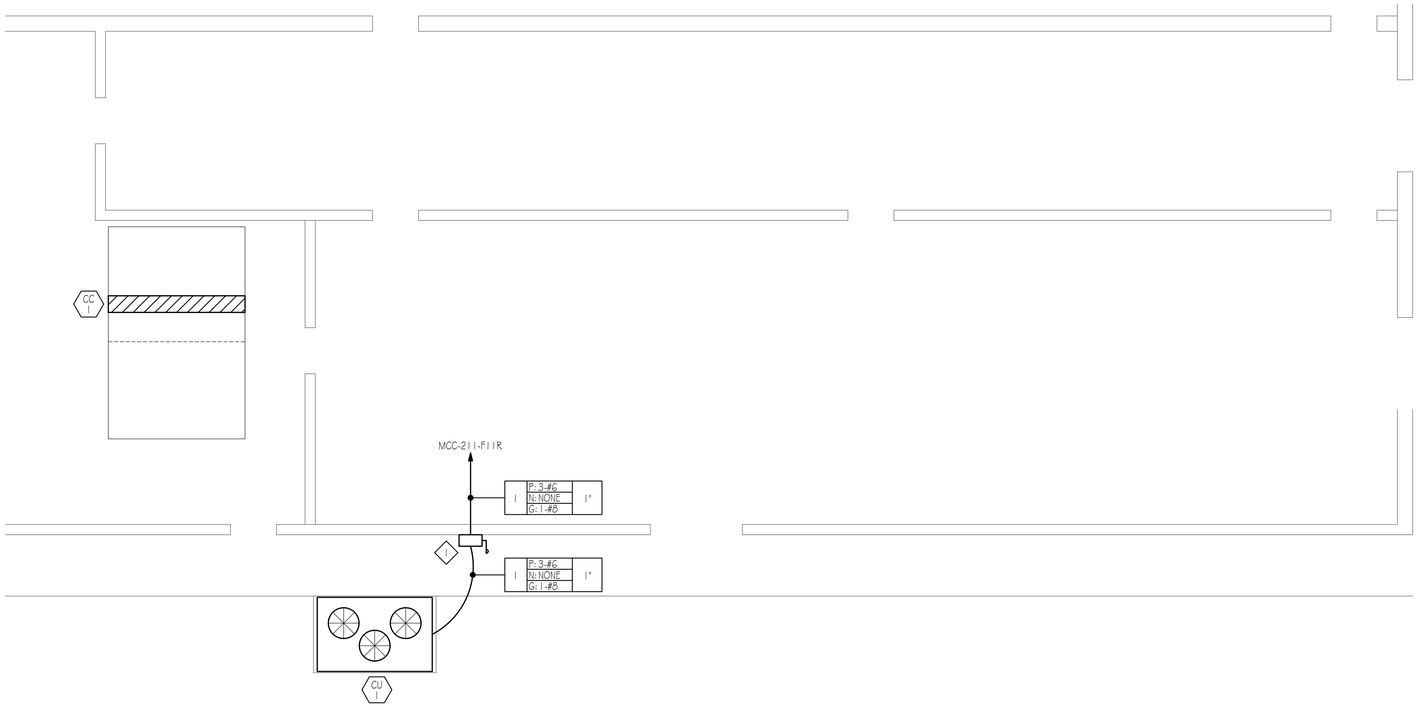
EDUCATION CENTER

ENLARGED POWER DEMOLITION AND REMODEL PLANS

SHEET NUMBER

E-401

11/14/2023 9:40 AM - I:\22099\01 - DWG\ELEC\SHEET\22099-E-401.DWG - KINKADE MINSON



1 E-102 RO BUILDING VFD AND MCC ROOMS POWER REMODEL PLAN

SCALE: 1/4"= 1'-0" 5 0 10

DRAWING NOTES

1 60 / 3 / FUSE PER NAMEPLATE / 3R / 600 / HD

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NOLAN E. JOHNSON
STATE OF UTAH
11/14/23

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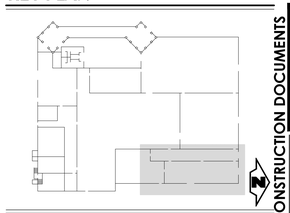
JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

KEY PLAN



HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

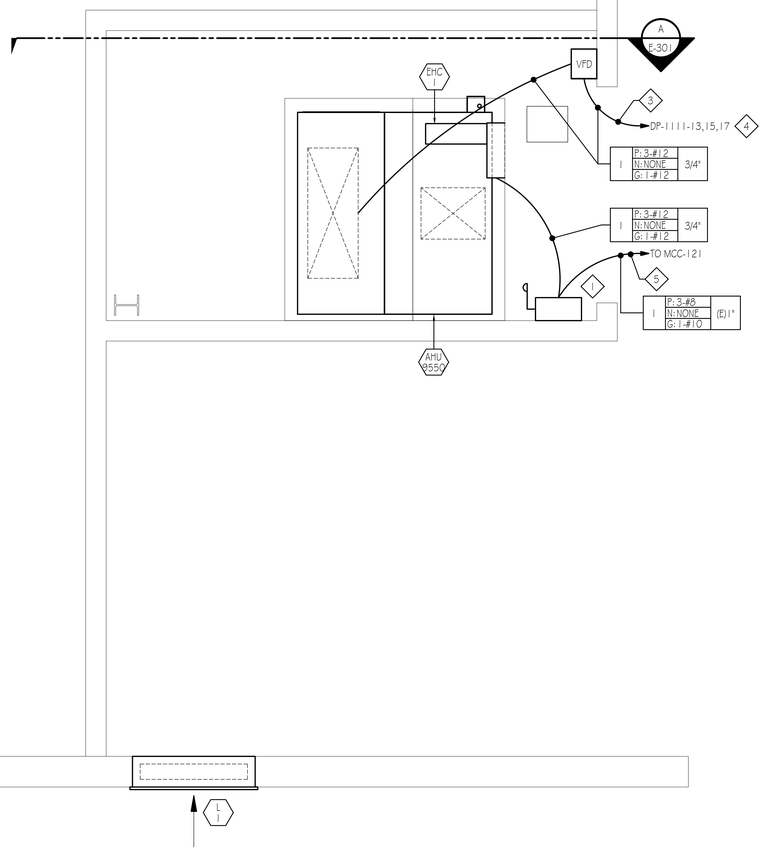
SHEET DESCRIPTION

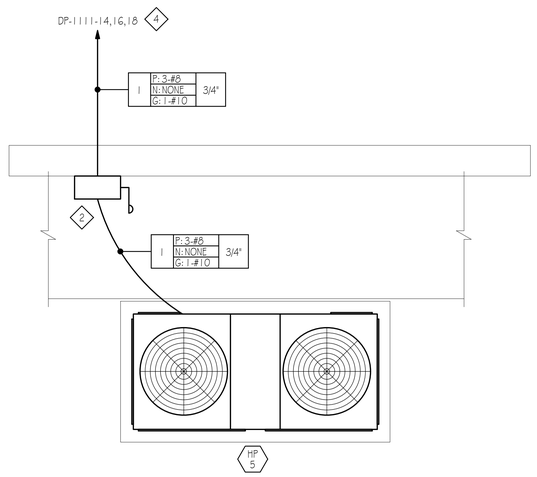
SWGWTP

VFD AND MCC ROOMS POWER REMODEL PLAN

SHEET NUMBER

E-102





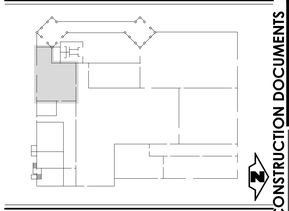
1 RO BUILDING MECHANICAL ROOM POWER REMODEL PLAN
E-103 SCALE: 1/2" = 1'-0"

2 0 5

DRAWING NOTES

1. 30 / 3 / FUSE PER NAMEPLATE / 1 / 600 / HD
2. 60 / 3 / FUSE PER NAMEPLATE / 3R / 600 / HD
3. EXISTING INSTALLED CONDUIT CAN BE REUSED IF APPLICABLE.
4. PROVIDE NEW BREAKER IN EXISTING PANEL. FIELD VERIFY PANEL SCHEDULE AND SPACE FOR NEW BREAKER. ADJUST AND REARRANGE EXISTING LOADS AND ASSOCIATED BREAKERS AS REQUIRED TO ACCOMMODATE NEW BREAKER LOCATIONS.
5. EXISTING CONDUIT, CONDUCTORS, AND BREAKER TO BE REUSED. REWORK CONDUIT AND CONDUCTORS AS NECESSARY TO NEW AHU EQUIPMENT.

KEY PLAN



HEATH Engineering Company

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PROFESSIONAL ENGINEER
328126
NOLAN E. JOHNSON
STATE OF UTAH
11/14/23

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

SHEET DESCRIPTION

SWGWTP

MECHANICAL ROOM POWER REMODEL PLAN

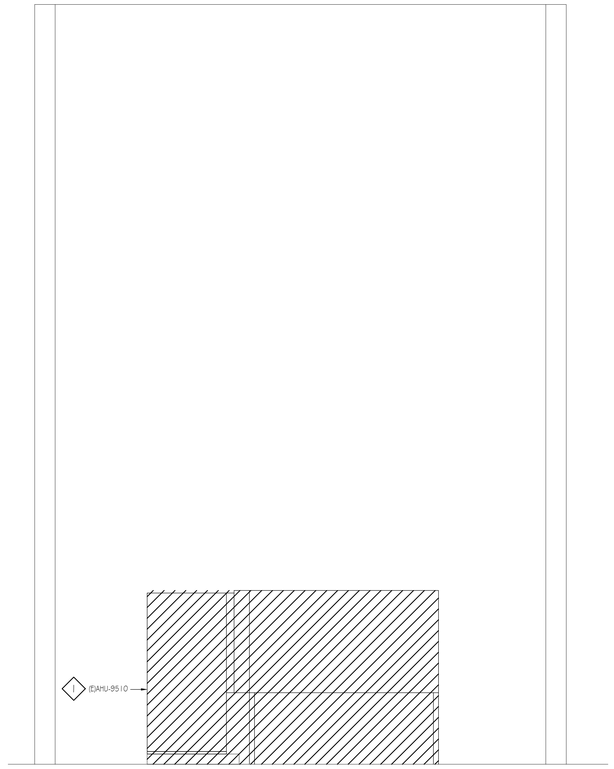
SHEET NUMBER

E-103

11/14/2023 9:40 AM - I:\22099\01 - DWG\ELEC\SHEET\22099-E-103.DWG - KINKADE MINSON

DRAWINGS NOTES

1. EXISTING MECHANICAL EQUIPMENT TO BE REMOVED. REMOVE ALL ASSOCIATED ELECTRICAL CONDUIT AND WIRING ALONG WITH CONTROLLER.



A E-301 MECHANICAL ROOM DEMOLITION SECTION

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

2 0 5

HEATH
Engineering Company

STAMP

PROFESSIONAL ENGINEER
328126
NOLAN E. JOHNSON
STATE OF UTAH
9/9/23

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

SHEET DESCRIPTION

SWGWTP

MECHANICAL ROOM SECTIONS

SHEET NUMBER

E-301

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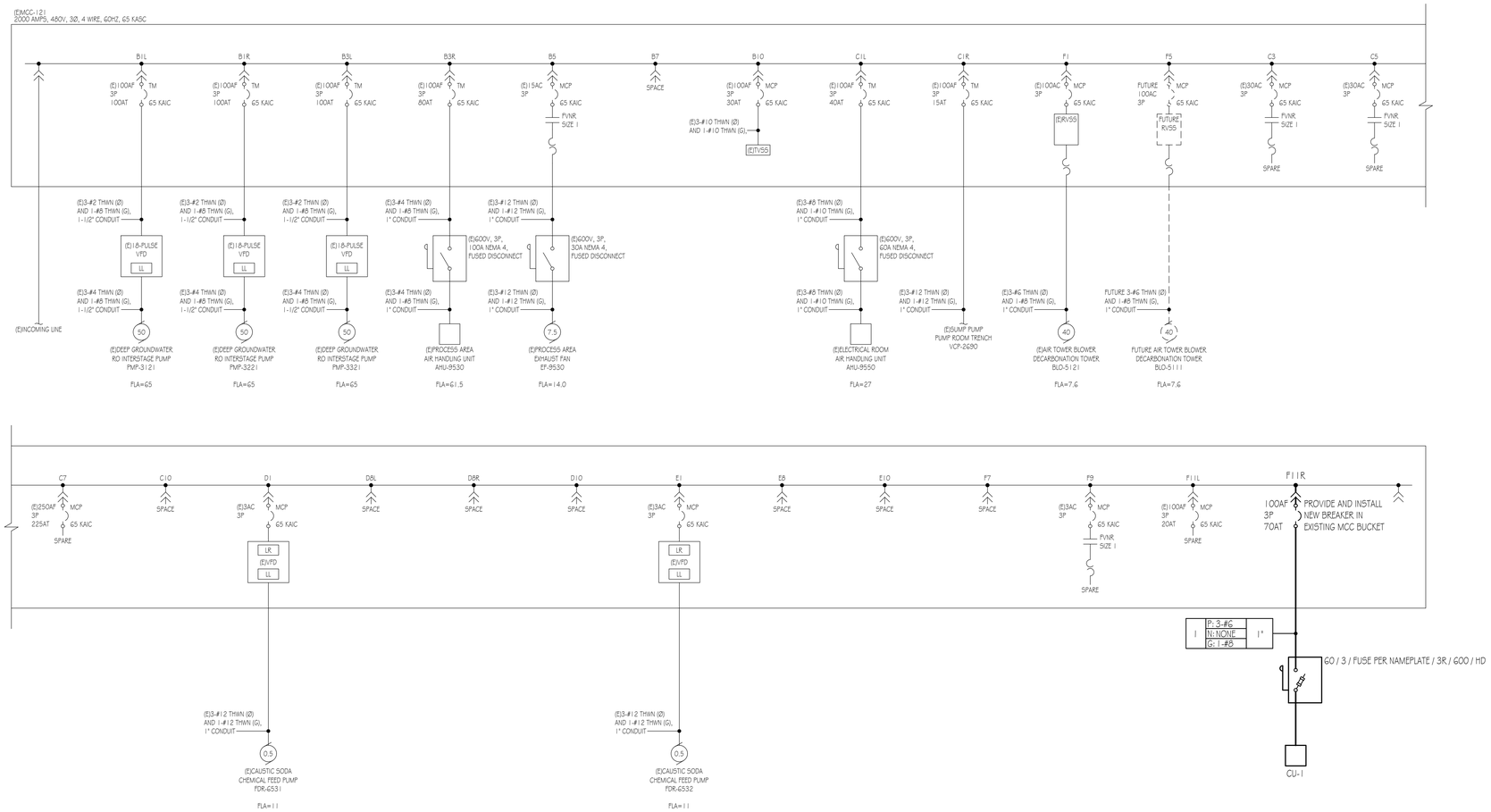


POWER ONE-LINE DIAGRAM

1 / E-601

SCALE: NONE

11/14/2023 9:40 AM - I:\22099\01 - DWG\ELEC\SHEET\22099-E-601.DWG - KINKADE MINSON

HEATH Engineering Company

STAMP

PROFESSIONAL ENGINEER
328126
NOLAN E. JOHNSON
STATE OF UTAH
11/14/23

REVISIONS:

JORDAN VALLEY WATER CONSERVANCY DISTRICT
SWGWTP PLANT AND EDUCATION CENTER HVAC IMPROVEMENTS

8215 SOUTH 1300 WEST
WEST JORDAN, UT 84088

CONSTRUCTION DOCUMENTS

HEATH PROJECT No:	22099
CHECKED BY:	NEJ
DRAWN BY:	KJB
DATE:	November 14, 2023

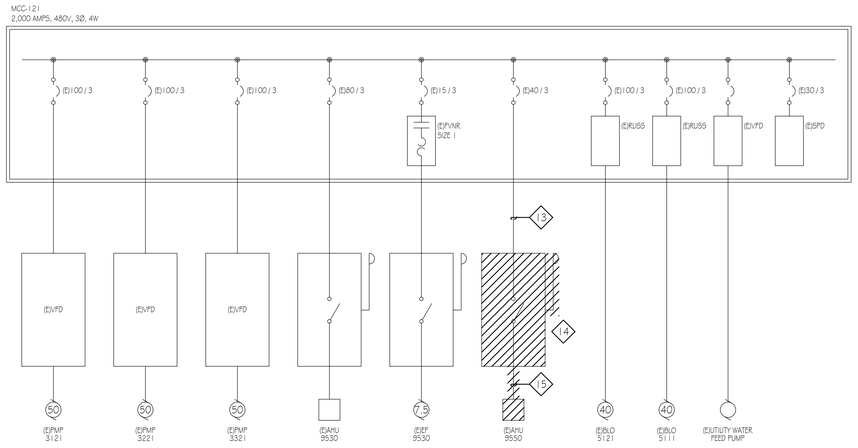
SHEET DESCRIPTION

SWGWTP

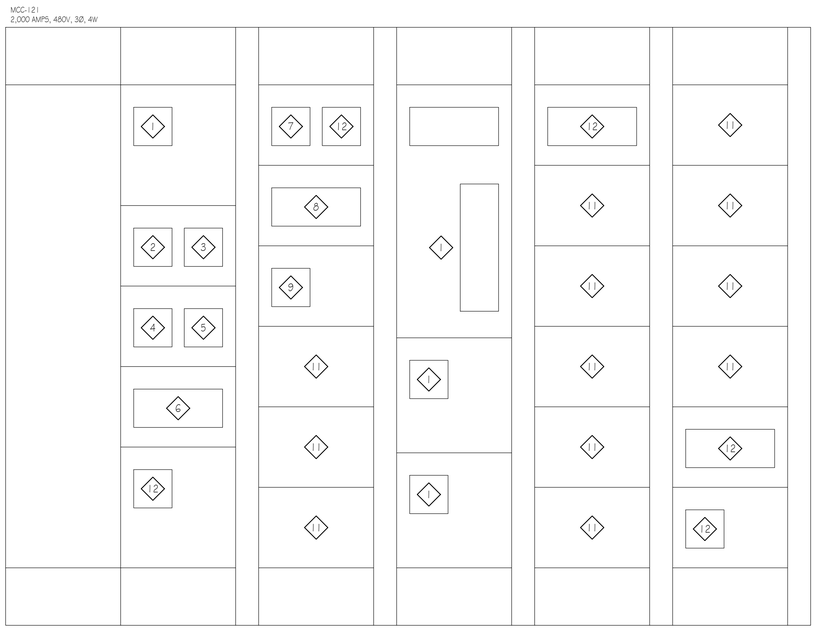
ELECTRICAL ONE-LINE DIAGRAM

SHEET NUMBER

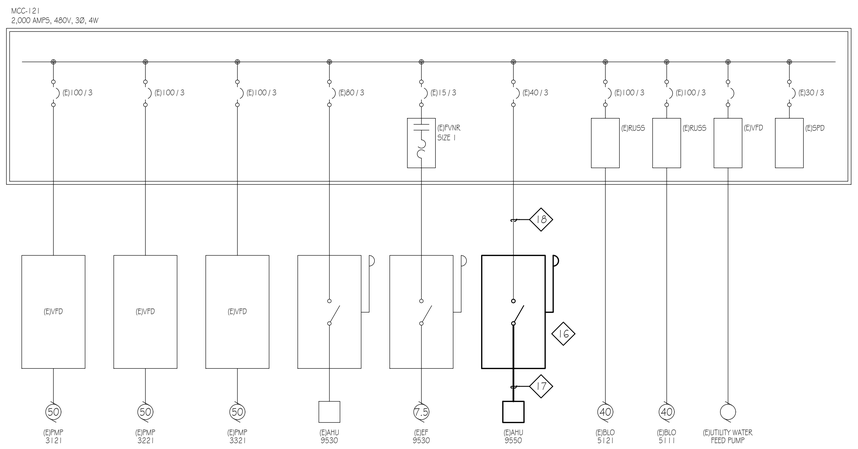
E-601



1 E-601 **MCC-121 DEMOLITION ONE-LINE DIAGRAM**
SCALE: NONE



1 E-601 **MCC-121 ELEVATION**
SCALE: NONE



1 E-601 **MCC-121 DEMOLITION ONE-LINE DIAGRAM**
SCALE: NONE

DRAWING NOTES

1. SPD
2. DEEP GROUND WATER RO INTER STAGE PUMP PMP-3121
3. DEEP GROUND WATER RP INTER STAGE PUMP PMP-3221
4. SHALLOW GROUND WATER RO INTER STAGE PUMP PMP-3321
5. PROCESS AREA AIR HANDLING UNIT AHU-9530
6. PROCESS AREA EXHAUST FAN EF-9530
7. ELECTRICAL ROOM AHU-9550
8. AIR TOWER BLOWER BLO-5111
9. AIR TOWER BLOWER BLO-5121
10. UTILITY WATER FEED PUMP PMP-9112
11. SPACE
12. SPARE
13. EXISTING CONDUIT AND CONDUCTORS TO REMAIN. SEE REMODEL PLAN.
14. REMOVE EXISTING DISCONNECT.
15. REMOVE EXISTING CONDUIT AND CONDUCTORS TO DEMOLISHED MECHANICAL EQUIPMENT.
16. NEW 30 / 3 / FUSE PER NAMEPLATE / 3 / 600 / HD
17. 1 | P: 3 - #12 / N: NONE / G: 1 - #12 | 3/4"
18. EXISTING CONDUIT AND CONDUCTORS TO BE REUSED. REWORK AS NECESSARY.

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SHEET DESCRIPTION
SWGWTP
ELECTRICAL ONE-LINE DIAGRAM

SHEET NUMBER
E-602