

CITY OF ANN ARBOR
INVITATION TO BID



WTP Ozone Generation Building Chiller Replacement

ITB No. 4550

Due Date: Monday, September 24, 2018 2:00 pm (Local Time)

Public Services Area/Water Treatment Services Unit
Administering Service Area/Unit

Issued By:

City of Ann Arbor
Procurement Unit
301 E. Huron Street
Ann Arbor, MI 48104

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- City of Ann Arbor Prevailing Wage Declaration Form*
- City of Ann Arbor Living Wage Forms*
- City of Ann Arbor Vendor Conflict of Interest Disclosure Form*
- City of Ann Arbor Non-Discrimination Ordinance Notice and Declaration Form*

NOTICE OF PRE-BID CONFERENCE

A pre-bid conference for this project will be held on **Monday, September 17, 2018 2:30 pm** at the Ann Arbor Water Treatment Plant, 919 Sunset Road, Ann Arbor, Michigan 48103.

This pre-bid conference will be the only opportunity for walkthroughs.

Attendance at this conference is highly recommended. Administrative and technical questions regarding this project will be answered at this time. The pre-bid conference is for information only. Any answers furnished will not be official until verified in writing by the Financial Service Area, Procurement Unit. Answers that change or substantially clarify the bid will be affirmed in an addendum.

INSTRUCTIONS TO BIDDERS

General

Work to be done under this Contract is generally described through the detailed specifications and must be completed fully in accordance with the contract documents. All work to be done under this Contract is located in or near the City of Ann Arbor.

Any Bid which does not conform fully to these instructions may be rejected.

Preparation of Bids

Bids should be prepared providing a straight-forward, concise description of the Bidder's ability to meet the requirements of the ITB. Bids shall be written in ink or typewritten. No erasures are permitted. Mistakes may be crossed out and corrected and must be initialed and dated in ink by the person signing the Bid.

Bids must be submitted on the "Bid Forms" provided with each blank properly filled in. If forms are not fully completed it may disqualify the bid. No alternative bid will be considered unless alternative bids are specifically requested. If alternatives are requested, any deviation from the specification must be fully described, in detail on the "Alternate" section of Bid form.

Each person signing the Bid certifies that he/she is the person in the Bidder's firm/organization responsible for the decision as to the fees being offered in the Bid and has not and will not participated in any action contrary to the terms of this provision.

Questions or Clarifications / Designated City Contacts

All questions regarding this ITB shall be submitted via email. Emailed questions and inquires will be accepted from any and all prospective Bidders in accordance with the terms and conditions of the ITB.

All questions shall be due on or before **Tuesday, September 18, 2018 by 1:00 pm** and should be addressed as follows:

Specification/Scope of Work questions emailed to greg.schofer@stantec.com
Bid Process and Compliance questions emailed to cspencer@a2gov.org

Any error, omissions or discrepancies in the specification discovered by a prospective contractor and/or service provider shall be brought to the attention of Greg Schofer at greg.schofer@stantec.com after discovery as possible. Further, the contractor and/or service provide shall not be allowed to take advantage of errors, omissions or discrepancies in the specifications.

Addenda

If it becomes necessary to revise any part of the ITB, notice of the Addendum will be posted to Michigan Inter-governmental Trade Network (MITN) www.mitn.info and/or City of Ann Arbor web site www.A2gov.org for all parties to download.

Each Bidder must in its Bid, to avoid any miscommunications, acknowledge all addenda which it has received, but the failure of a Bidder to receive, or acknowledge receipt of; any addenda shall not relieve the Bidder of the responsibility for complying with the terms thereof.

The City will not be bound by oral responses to inquiries or written responses other than written addenda.

Bid Submission

All Bids are due and must be delivered to the City of Ann Arbor Procurement Unit on or before **Monday, September 24, 2018 at 2:00 pm EST**. Bids submitted late or via oral, telephonic, telegraphic, electronic mail or facsimile **will not** be considered or accepted.

Each Bidder must submit one (1) original Bid and **Five (5)** Bid copies in a sealed envelope clearly marked: **ITB No. 4550 WTP Ozone Generation Building Chiller Replacement**.

Bids must be addressed and delivered to:

City of Ann Arbor
Procurement Unit,
c/o Customer Services, 1st Floor
301 East Huron Street
Ann Arbor, MI 48107

All Bids received on or before the Due Date will be publicly opened and recorded immediately. No immediate decisions are rendered.

The following forms provided within this ITB Document must be included in submitted bids.

- **City of Ann Arbor Prevailing Wage Declaration of Compliance**
- **City of Ann Arbor Living Wage Ordinance Declaration of Compliance**
- **Vendor Conflict of Interest Disclosure Form**
- **City of Ann Arbor Non-Discrimination Ordinance Declaration of Compliance**

Bids that fail to provide these completed forms listed above upon bid opening will be rejected as non-responsive and will not be considered for award.

Hand delivered bids will be date/time stamped/signed by the Procurement Unit at the address above in order to be considered. Normal business hours are 9:00 a.m. to 3:00 p.m. Monday through Friday, excluding Holidays. The City will not be liable to any Bidder for any unforeseen circumstances, delivery or postal delays. Postmarking to the Due Date will not substitute for receipt of the Bid. Each Bidder is responsible for submission of their Bid.

Additional time for submission of bids past the stated due date and time will not be granted to a single Bidder; however, additional time may be granted to all Bidders when the City determines in its sole discretion that circumstances warrant it.

Award

The City intends to award a Contract(s) to the lowest responsible Bidder(s). On multi-divisional contracts, separate divisions may be awarded to separate Bidders. The City may also utilize alternatives offered in the Bid Forms, if any, to determine the lowest responsible Bidder on each division, and award multiple divisions to a single Bidder, so that the lowest total cost is achieved for the City. For unit price bids, the Contract will be awarded based upon the unit prices and the lump sum prices stated by the bidder for the work items specified in the bid documents, with consideration given to any alternates selected by the City. If the City determines that the unit price for any item is materially different for the work item bid than either other bidders or the general market, the City, in its sole discretion, in addition to any other right it may have, may reject the bid

as not responsible or non-conforming.

The acceptability of major subcontractors will be considered in determining if a Bidder is responsible. In comparing Bids, the City will give consideration to alternate Bids for items listed in the bid forms. All key staff and subcontractors are subject to the approval by the City.

Official Documents

The City of Ann Arbor officially distributes bid documents from the Procurement Unit or through the Michigan Intergovernmental Trade Network (MITN). Copies of the bid documents obtained from any other source are not Official copies. Addenda and other bid information will only be posted to these official distribution sites. If you obtained City of Ann Arbor Bid documents from other sources, it is recommended that you register on www.MITN.info and obtain an official Bid. Bidders do not need to be shown on the plan holders list provided by MITN to be considered an official plan holder.

Bid Security

Each bid must be accompanied by a certified check or Bid Bond by a surety licensed and authorized to do business within the State of Michigan, in the amount of 5% of the total of the bid price.

Withdrawal of Bids

After the time of opening, no Bid may be withdrawn for the period of One Hundred and Twenty (120) days

Contract Time

Time is of the essence in the performance of the work under this Contract. The available time for work under this Contract is indicated on page C-1, Article III of the Contract. If these time requirements cannot be met, the Bidder must stipulate on Bid Form Section 3 - Time Alternate its schedule for performance of the work. Consideration will be given to time in evaluating bids.

Liquidated Damages

A liquidated damages clause, as given on page C-2, Article III of the Contract, provides that the Contractor shall pay the City as liquidated damages, and not as a penalty, a sum certain per day for each and every day that the Contractor may be in default of completion of the specified work, within the time(s) stated in the Contract, or written extensions.

Liquidated damages clauses, as given in the General Conditions, provide further that the City shall be entitled to impose and recover liquidated damages for breach of the obligations under Chapter 112 of the City Code.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

Human Rights Information

All contractors proposing to do business with the City shall satisfy the contract compliance administrative policy adopted by the City Administrator in accordance with the Section 9:158 of the Ann Arbor City Code. Breach of the obligation not to discriminate as outlined in Section 5, beginning at page GC-2 shall be a material breach of the contract. Contractors are required to post a copy of Ann Arbor's Non-Discrimination Ordinance attached at all work locations where its

employees provide services under a contract with the City.

Wage Requirements

Section 4, beginning at page GC-1, outlines the requirements for payment of prevailing wages and for payment of a “living wage” to employees providing service to the City under this contract. The successful bidder and its subcontractors must comply with all applicable requirements and provide proof of compliance.

Pursuant to Resolution R-16-469 all public improvement contractors are subject to prevailing wage and will be required to provide to the City payroll records sufficient to demonstrate compliance with the prevailing wage requirements. Use of the Prevailing Wage Form provided in the Appendix section or a City-approved equivalent will be required along with wage rate interviews.

For laborers whose wage level are subject to federal, state and/or local prevailing wage law the appropriate Davis-Bacon wage rate classification is identified based upon the work including within this contract. **The wage determination(s) current on the date 10 days before bids are due shall apply to this contract.** The U.S. Department of Labor (DOL) has provided explanations to assist with classification in the following resource link: www.wdol.gov.

For the purposes of this ITB the Construction Type of Building will apply.

Conflict of Interest Disclosure

The City of Ann Arbor Purchasing Policy requires that prospective Vendors complete a Conflict of Interest Disclosure form. A contract may not be awarded to the selected Vendor unless and until the Procurement Unit and the City Administrator have reviewed the Disclosure form and determined that no conflict exists under applicable federal, state, or local law or administrative regulation. Not every relationship or situation disclosed on the Disclosure Form may be a disqualifying conflict. Depending on applicable law and regulations, some contracts may be awarded on the recommendation of the City Administrator after full disclosure, where such action is allowed by law, if demonstrated competitive pricing exists and/or it is determined the award is in the best interest of the City. A copy of the Vendor Conflict of Interest Disclosure Form is attached.

Major Subcontractors

The Bidder shall identify on Bid Form Section 4 each major subcontractor it expects to engage for this Contract if the work to be subcontracted is 15% or more of the bid sum or over \$50,000, whichever is less. The Bidder also shall identify the work to be subcontracted to each major subcontractor. The Bidder shall not change or replace a subcontractor without approval by the City.

Debarment

Submission of a Bid in response to this ITB is certification that the Bidder is not currently debarred, suspended, proposed for debarment, and declared ineligible or voluntarily excluded from participation in this transaction by any State or Federal departments or agency. Submission is also agreement that the City will be notified of any changes in this status.

Disclosures

After bids are opened, all information in a submitter’s bid is subjected to disclosure under the provisions of Michigan Public Act No. 442 of 1976, as amended (MCL 15.231 et seq.) known as

the “Freedom of Information Act.” The Freedom of Information Act also provides for the complete disclosure of contracts and attachments thereto except where specifically exempted.

Bid Protest

All Bid protests must be in writing and filed with the Purchasing Agent within five (5) business days of the award action. The bidder must clearly state the reasons for the protest. If a bidder contacts a City Service Area/Unit and indicates a desire to protest an award, the Service Area/Unit shall refer the bidder to the Purchasing Agent. The Purchasing Agent will provide the bidder with the appropriate instructions for filing the protest. The protest shall be reviewed by the City Administrator or designee whose decision shall be final.

Any inquiries or requests regarding this procurement should be only submitted in writing to the Designated City Contacts provided herein. Attempts by any prospective bidder to initiate contact with anyone other than the Designated City Contacts provided herein that the bidder believes can influence the procurement decision, e.g., Elected Officials, City Administrator, Selection Committee Members, Appointed Committee Members, etc., may lead to immediate elimination from further consideration.

Cost Liability

The City of Ann Arbor assumes no responsibility or liability for costs incurred by the Bidder prior to the execution of a contract with the City. By submitting a bid, a bidder agrees to bear all costs incurred or related to the preparation, submission and selection process for the bid.

Reservation of Rights

The City of Ann Arbor reserves the right to accept any bid or alternative bid proposed in whole or in part, to reject any or all bids or alternatives bids in whole or in part and to waive irregularity and/or informalities in any bid and to make the award in any manner deemed in the best interest of the City.

Idlefree Ordinance

The City of Ann Arbor adopted an idling reduction Ordinance that goes into effect July 1, 2017. The full text of the ordinance (including exemptions) can be found at: www.a2gov.org/idlefree.

Under the ordinance, No Operator of a Commercial Vehicle shall cause or permit the Commercial Vehicle to Idle:

- (a) For any period of time while the Commercial Vehicle is unoccupied; or
- (b) For more than 5 minutes in any 60-minute period while the Commercial Vehicle is occupied.

In addition, generators and other internal combustion engines are covered

(1) Excluding Motor Vehicle engines, no internal combustion engine shall be operated except when it is providing power or electrical energy to equipment or a tool that is actively in use.

Environmental Commitment

The City of Ann Arbor recognizes its responsibility to minimize negative impacts on human health and the environment while supporting a vibrant community and economy. The City further recognizes that the products and services the City buys have inherent environmental and economic impacts and that the City should make procurement decisions that embody, promote, and encourage the City’s commitment to the environment.

The City encourages potential vendors to bring forward emerging and progressive products and services that are best suited to the City's environmental principles.

SUPPLEMENTAL INSTRUCTIONS TO BIDDERS

Bidders shall submit with their Bid, responses to the following. Responses shall be prepared to numerically match the itemized list as follows:

1. Bidder shall submit a formal/written safety program.
2. Bidder shall describe the job site safety program for this project and specific safety policies in which employees must be in compliance.
3. Bidder shall provide the organizations most current OSHA 300 logs of reasons why this organization is exempt form OSHA 300 reporting.
4. Bidder shall provide the organization's more recent OSHA recordable incident rate, DART rate, and lost workday rate.
5. Bidder shall identify any accidents or incidents that resulted in major injury or deaths that have occurred on a project site controlled by the firm, or any subcontractor(s). If such an incident has occurred, describe how the organization revised the program.
6. Bidders shall identify the project safety team, their qualifications, duties and city(s) of residence.

INVITATION TO BID

City of Ann Arbor
Guy C. Larcom Municipal Building
Ann Arbor, Michigan 48107

Ladies and Gentlemen:

The undersigned, as Bidder, declares that this Bid is made in good faith, without fraud or collusion with any person or persons bidding on the same Contract; that this Bidder has carefully read and examined the bid documents, including City Nondiscrimination requirements and Declaration of Compliance Form, Living Wage requirements and Declaration of Compliance Form, Prevailing Wage requirements and Declaration of Compliance Form, Vendor Conflict of Interest Form, Notice of Pre-Bid Conference, Instructions to Bidders, Bid, Bid Forms, Contract, Bond Forms, General Conditions, Standard Specifications, Detailed Specifications, all Addenda, and the Plans (if applicable) and understands them. The Bidder declares that it conducted a full investigation at the site and of the work proposed and is fully informed as to the nature of the work and the conditions relating to the work's performance. The Bidder also declares that it has extensive experience in successfully completing projects similar to this one.

The Bidder acknowledges that it has not received or relied upon any representations or warrants of any nature whatsoever from the City of Ann Arbor, its agents or employees, and that this Bid is based solely upon the Bidder's own independent business judgment.

The undersigned proposes to perform all work shown on the plans or described in the bid documents, including any addenda issued, and to furnish all necessary machinery, tools, apparatus, and other means of construction to do all the work, furnish all the materials, and complete the work in strict accordance with all terms of the Contract of which this Bid is one part.

In accordance with these bid documents, and Addenda numbered _____, the undersigned, as Bidder, proposes to perform at the sites in and/or around Ann Arbor, Michigan, all the work included herein for the amounts set forth in the Bid Forms.

The Bidder declares that it has become fully familiar with the liquidated damage clauses for completion times and for compliance with City Code Chapter 112, understands and agrees that the liquidated damages are for the non-quantifiable aspects of non-compliance and do not cover actual damages that may be shown and agrees that if awarded the Contract, all liquidated damage clauses form part of the Contract.

The Bidder declares that it has become fully familiar with the provisions of Chapter 14, Section 1:320 (Prevailing wages) and Chapter 23 (Living Wage) of the Code of the City of Ann Arbor and that it understands and agrees to comply, to the extent applicable to employees providing services to the City under this Contract, with the wage and reporting requirements stated in the City Code provisions cited. Bidder certifies that the statements contained in the City Prevailing Wage and Living Wage Declaration of Compliance Forms are true and correct. Bidder further agrees that the cited provisions of Chapter 14 and Chapter 23 form a part of this Contract.

The Bidder declares that it has become familiar with the City Conflict of Interest Disclosure Form and certifies that the statement contained therein is true and correct.

The Bidder encloses a certified check or Bid Bond in the amount of 5% of the total of the Bid Price. The Bidder agrees both to contract for the work and to furnish the necessary Bonds and insurance documentation within 10 days after being notified of the acceptance of the Bid.

If this Bid is accepted by the City and the Bidder fails to contract and furnish the required Bonds and insurance documentation within 10 days after being notified of the acceptance of this Bid, then the Bidder shall be considered to have abandoned the Contract and the certified check or Bid Bond accompanying this Bid shall become due and payable to the City.

If the Bidder enters into the Contract in accordance with this Bid, or if this Bid is rejected, then the accompanying check or Bid Bond shall be returned to the Bidder.

In submitting this Bid, it is understood that the right is reserved by the City to accept any Bid, to reject any or all Bids, to waive irregularities and/or informalities in any Bid, and to make the award in any manner the City believes to be in its best interest.

SIGNED THIS _____ DAY OF _____, 201_.

Bidder's Name

Authorized Signature of Bidder

Official Address

(Print Name of Signer Above)

Telephone Number

Email Address for Award Notice

LEGAL STATUS OF BIDDER

(The Bidder shall fill out the appropriate form and strike out the other three.)

Bidder declares that it is:

* A corporation organized and doing business under the laws of the State of _____, for whom _____, bearing the office title of _____, whose signature is affixed to this Bid, is authorized to execute contracts.

NOTE: If not incorporated in Michigan, please attach the corporation's Certificate of Authority

• A limited liability company doing business under the laws of the State of _____, whom _____ bearing the title of _____ whose signature is affixed to this proposal, is authorized to execute contract on behalf of the LLC.

* A partnership, organized under the laws of the state of _____ and filed in the county of _____, whose members are (list all members and the street and mailing address of each) (attach separate sheet if necessary):

* An individual, whose signature with address, is affixed to this Bid: _____
(initial here)

Authorized Official

_____ **Date** _____, 201__

(Print) Name _____ Title _____

Company: _____

Address: _____

Contact Phone () _____ Fax () _____

Email _____

BID FORM

Section 1 – Schedule of Prices

Company: _____

Project: **WTP Ozone Generation Building Chiller Replacement**

Base Bid

Trane Equipment 60 and 100 Ton Chiller

For the entire work outlined in these documents for **WTP Ozone Generation Building Chiller Replacement**, complete as specified, using equipment and materials only of the type and manufacturers where specifically named with warranty of two (2) years from commissioning dates of each chiller.

_____ (\$_____)

(Amount shall be shown in both work figures. In case of a discrepancy, the amount shown in words shall govern.)

Alternate #1

Substitute Equipment 60 and 100 Ton Chiller

For the entire work outlined in these documents for **WTP Ozone Generation Building Chiller Replacement**, complete as specified, using equipment and materials only of the type and alternative manufacturers where specifically named with warranty of two (2) years from commissioning dates of each chiller. Must complete Bid Form Section 2 (BF-2) - Material, Equipment and Environmental Alternates.

Manufacturer: _____

Add / Deduct (Must Circle One) to Base Bid.

(In case of non-selection, the amount will be added to the Base Bid.)

_____ (\$_____)

(Amount shall be shown in both work figures. In case of a discrepancy, the amount shown in words shall govern.)

Alternate #2

Warranty Extension Bid – Trane 60 Ton Chiller Only

Additional cost for an additional three (3) years for a total of five (5) years of warranty. Warranty costs will include all necessary maintenance, material (chemicals) and labor as required.

_____ (\$_____)

(Amount shall be shown in both work figures. In case of a discrepancy, the amount shown in words shall govern.)

Alternate #3

Warranty Extension Bid – Trane 100 Ton Chiller Only

Additional cost for an additional three (3) years for a total of five (5) years of warranty. Warranty costs will include all necessary maintenance, material (chemicals) and labor as required.

_____ (\$_____)

(Amount shall be shown in both work figures. In case of a discrepancy, the amount shown in words shall govern.)

Alternate #4

Warranty Extension Bid – Substitute 60 Ton Chiller Only

Additional cost for an additional three (3) years for a total of five (5) years of warranty. Warranty costs will include all necessary maintenance, material (chemicals) and labor as required.

Manufacturer: _____

_____ (\$_____)

(Amount shall be shown in both work figures. In case of a discrepancy, the amount shown in words shall govern.)

Alternate #5

Warranty Extension Bid – Substitute 100 Ton Chiller Only

Additional cost for an additional three (3) years for a total of five (5) years of warranty. Warranty costs will include all necessary maintenance, material (chemicals) and labor as required.

Manufacturer: _____

_____ (\$_____)

(Amount shall be shown in both work figures. In case of a discrepancy, the amount shown in words shall govern.)

BID FORM

Section 2 – Material, Equipment and Environmental Alternates

The Base Bid proposal price shall include materials and equipment selected from the designated items and manufacturers listed in the bidding documents. This is done to establish uniformity in bidding and to establish standards of quality for the items named.

If the Contractor wishes to quote alternate items for consideration by the City, it may do so under this Section. A complete description of the item and the proposed price differential must be provided. Unless approved at the time of award, substitutions where items are specifically named will be considered only as a negotiated change in Contract Sum.

If an environmental alternative is bid the City strongly encourages bidders to provide recent examples of product testing and previous successful use for the City to properly evaluate the environmental alternative. Testing data from independent accredited organizations are strongly preferred.

<u>Item Number</u>	<u>Description</u>	<u>Add/Deduct Amount</u>
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If the Bidder does not suggest any material or equipment alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any material or equipment alternate under the Contract.

Signature of Authorized Representative of Bidder _____ Date _____

BID FORM

Section 3 - Time Alternate

If the Bidder takes exception to the time stipulated in Article III of the Contract, Time of Completion, page C-1, it is requested to stipulate below its proposed time for performance of the work. Consideration will be given to time in evaluating bids.

If the Bidder does not suggest any time alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any time alternate under the Contract.

Signature of Authorized Representative of Bidder _____ Date _____

BID FORM

Section 4 - Major Subcontractors

For purposes of this Contract, a Subcontractor is anyone (other than the Contractor) who performs work (other than or in addition to the furnishing of materials, plans or equipment) at or about the construction site, directly or indirectly for or on behalf of the Contractor (and whether or not in privity of Contract with the Contractor), but shall not include any individual who furnishes merely the individual's own personal labor or services.

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision to Section 4 of the General Conditions covering subcontractor's employees who perform work on this contract.

For the work outlined in these documents the Bidder expects to engage the following major subcontractors to perform the work identified:

<u>Subcontractor (Name and Address)</u>	<u>Work</u>	<u>Amount</u>
	Chiller Supplier	
	Chiller Supplier (Alternative)	
	Mechanical Work	
	Electrical Work	

If the Bidder does not expect to engage any major subcontractor, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT expect to engage any major subcontractor to perform work under the Contract.

Signature of Authorized Representative of Bidder _____ Date _____

SAMPLE STANDARD CONTRACT

If a contract is awarded, the selected contractor will be required to adhere to a set of general contract provisions which will become a part of any formal agreement. These provisions are general principles which apply to all contractors of service to the City of Ann Arbor such as the following:

CONTRACT

THIS AGREEMENT is made on the _____ day of _____, 201_, between the CITY OF ANN ARBOR, a Michigan Municipal Corporation, 301 East Huron Street, Ann Arbor, Michigan 48104 ("City") and _____ ("Contractor")

(An individual/partnership/corporation, include state of incorporation)

(Address)

Based upon the mutual promises below, the Contractor and the City agree as follows:

ARTICLE I - Scope of Work

The Contractor agrees to furnish all of the materials, equipment and labor necessary; and to abide by all the duties and responsibilities applicable to it for the project titled WTP Ozone Generation Building Chiller Replacement ITB No. 4550 in accordance with the requirements and provisions of the following documents, including all written modifications incorporated into any of the documents, which are incorporated as part of this Contract:

Non-discrimination and Living Wage Declaration of Compliance Forms (if applicable)
Vendor Conflict of Interest Form
Prevailing Wage Declaration of Compliance Form (if applicable)
Bid Forms
Contract and Exhibits
Bonds

General Conditions
Standard Specifications
Detailed Specifications
Plans
Addenda

ARTICLE II - Definitions

Administering Service Area/Unit means Public Services Area/Water Treatment Services Unit

Project means WTP Ozone Generation Building Chiller Replacement ITB No. 4550

ARTICLE III - Time of Completion

- (A) The work to be completed under this Contract shall begin immediately on the date specified in the Notice to Proceed issued by the City.
- (B) The entire work for this Contract shall be performed based on the following:
 - 40-ton chiller: Substantial Completion 18 weeks after first Notice to Proceed. Final Completion 2 weeks after Substantial Completion.
 - 100-ton chiller: Substantial Completion 16 weeks after second Notice to Proceed. Final Completion 2 weeks after Substantial Completion.

- As a guide in preparing the bid, the following approximate schedule is provided:
 - o First Notice to Proceed (40-ton chiller) – January 7, 2019
 - o 40-ton chiller Substantial Completion – May 10, 2019 or earlier
 - o Second Notice to Proceed (100-ton chiller) – December 2, 2019
 - o 100-ton chiller Substantial Completion – March 20, 2020
 - The approximate schedule is based upon the need for chilled water and the completion dates are critical to meet.
- (C) Failure to complete all the work within the time specified above, including any extension granted in writing by the Supervising Professional, shall obligate the Contractor to pay the City, as liquidated damages and not as a penalty, an amount equal to \$500.00 for each calendar day of delay in the completion of all the work. If any liquidated damages are unpaid by the Contractor, the City shall be entitled to deduct these unpaid liquidated damages from the monies due the Contractor.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

ARTICLE IV - The Contract Sum

- (A) The City shall pay to the Contractor for the performance of the Contract, the lump sum price as given in the Bid Form in the amount of:

_____ Dollars (\$ _____)

- (B) The amount paid shall be equitably adjusted to cover changes in the work ordered by the Supervising Professional but not required by the Contract Documents. Increases or decreases shall be determined only by written agreement between the City and Contractor.

ARTICLE V - Assignment

This Contract may not be assigned or subcontracted any portion of any right or obligation under this contract without the written consent of the City. Notwithstanding any consent by the City to any assignment, Contractor shall at all times remain bound to all warranties, certifications, indemnifications, promises and performances, however described, as are required of it under this contract unless specifically released from the requirement, in writing, by the City.

ARTICLE VI - Choice of Law

This Contract shall be construed, governed, and enforced in accordance with the laws of the State of Michigan. By executing this agreement, the Contractor and the City agree to venue in a court of appropriate jurisdiction sitting within Washtenaw County for purposes of any action arising under this Contract. The parties stipulate that the venue referenced in this Contract is for convenience and waive any claim of non-convenience.

Whenever possible, each provision of the Contract will be interpreted in a manner as to be effective and valid under applicable law. The prohibition or invalidity, under applicable law, of any provision will not invalidate the remainder of the Contract.

ARTICLE VII - Relationship of the Parties

The parties of the Contract agree that it is not a Contract of employment but is a Contract to accomplish a specific result. Contractor is an independent Contractor performing services for the City. Nothing contained in this Contract shall be deemed to constitute any other relationship between the City and the Contractor.

Contractor certifies that it has no personal or financial interest in the project other than the compensation it is to receive under the Contract. Contractor certifies that it is not, and shall not become, overdue or in default to the City for any Contract, debt, or any other obligation to the City including real or personal property taxes. City shall have the right to set off any such debt against compensation awarded for services under this agreement.

ARTICLE VIII - Notice

All notices given under this Contract shall be in writing and shall be by personal delivery or by certified mail with return receipt requested to the parties at their respective addresses as specified in the Contract Documents or other address the Contractor may specify in writing. Notice will be deemed given on the date when one of the following first occur: (1) the date of actual receipt; or (2) three days after mailing certified U.S. mail.

ARTICLE IX - Indemnification

To the fullest extent permitted by law, Contractor shall indemnify, defend and hold harmless the City, its officers, employees and agents harmless from all suits, claims, judgments and expenses including attorney's fees resulting or alleged to result, in whole or in part, from any act or omission, which is in any way connected or associated with this Contract, by the Contractor or anyone acting on the Contractor's behalf under this Contract. Contractor shall not be responsible to indemnify the City for losses or damages caused by or resulting from the City's sole negligence. The provisions of this Article shall survive the expiration or earlier termination of this contract for any reason.

ARTICLE X - Entire Agreement

This Contract represents the entire understanding between the City and the Contractor and it supersedes all prior representations, negotiations, agreements, or understandings whether written or oral. Neither party has relied on any prior representations in entering into this Contract. No terms or conditions of either party's invoice, purchase order or other administrative document shall modify the terms and conditions of this Contract, regardless of the other party's failure to object to such form. This Contract shall be binding on and shall inure to the benefit of the parties to this Contract and their permitted successors and permitted assigns and nothing in this Contract, express or implied, is intended to or shall confer on any other person or entity any legal or equitable right, benefit, or remedy of any nature whatsoever under or by reason of this Contract. This Contract may be altered, amended or modified only by written amendment signed by the City and the Contractor.

FOR CONTRACTOR

By _____

Its: _____

FOR THE CITY OF ANN ARBOR

By _____
Christopher Taylor, Mayor

By _____
Jacqueline Beaudry, City Clerk

Approved as to substance

By _____
City Administrator

By _____
Services Area Administrator

Approved as to form and content

Stephen K. Postema, City Attorney

PERFORMANCE BOND

- (1) _____ of _____ (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for \$ _____, the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.
- (2) The Principal has entered a written Contract with the City dated _____, 201_, for: WTP Ozone Generation Building Chiller Replacement and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq.
- (3) Whenever the Principal is declared by the City to be in default under the Contract, the Surety may promptly remedy the default or shall promptly:
- (a) complete the Contract in accordance with its terms and conditions; or
 - (b) obtain a bid or bids for submission to the City for completing the Contract in accordance with its terms and conditions, and upon determination by Surety of the lowest responsible bidder, arrange for a Contract between such bidder and the City, and make available, as work progresses, sufficient funds to pay the cost of completion less the balance of the Contract price; but not exceeding, including other costs and damages for which Surety may be liable hereunder, the amount set forth in paragraph 1.
- (4) Surety shall have no obligation to the City if the Principal fully and promptly performs under the Contract.
- (5) Surety agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder, or the specifications accompanying it shall in any way affect its obligations on this bond, and waives notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work, or to the specifications.

SIGNED AND SEALED this _____ day of _____, 201_.

(Name of Surety Company)
By _____
(Signature)
Its _____
(Title of Office)

(Name of Principal)
By _____
(Signature)
Its _____
(Title of Office)

Approved as to form:

Name and address of agent:

Stephen K. Postema, City Attorney

LABOR AND MATERIAL BOND

- (1) _____
of _____ (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan, (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for the use and benefit of claimants as defined in Act 213 of Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq., in the amount of \$ _____, for the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.
- (2) The Principal has entered a written Contract with the City, dated _____, 201_, for WTP Ozone Generation Building Chiller Replacement; and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963 as amended;
- (3) If the Principal fails to promptly and fully repay claimants for labor and material reasonably required under the Contract, the Surety shall pay those claimants.
- (4) Surety's obligations shall not exceed the amount stated in paragraph 1, and Surety shall have no obligation if the Principal promptly and fully pays the claimants.

SIGNED AND SEALED this _____ day of _____, 201_

(Name of Surety Company)
By _____
(Signature)

Its _____
(Title of Office)

Approved as to form:

Stephen K. Postema, City Attorney

(Name of Principal)
By _____
(Signature)

Its _____
(Title of Office)

Name and address of agent:

GENERAL CONDITIONS

Section 1 - Execution, Correlation and Intent of Documents

The contract documents shall be signed in 2 copies by the City and the Contractor.

The contract documents are complementary and what is called for by any one shall be binding. The intention of the documents is to include all labor and materials, equipment and transportation necessary for the proper execution of the work. Materials or work described in words which so applied have a well-known technical or trade meaning have the meaning of those recognized standards.

In case of a conflict among the contract documents listed below in any requirement(s), the requirement(s) of the document listed first shall prevail over any conflicting requirement(s) of a document listed later.

(1) Addenda in reverse chronological order; (2) Detailed Specifications; (3) Standard Specifications; (4) Plans; (5) General Conditions; (6) Contract; (7) Bid Forms; (8) Bond Forms; (9) Bid.

Section 2 - Order of Completion

The Contractor shall submit with each invoice, and at other times reasonably requested by the Supervising Professional, schedules showing the order in which the Contractor proposes to carry on the work. They shall include the dates at which the Contractor will start the several parts of the work, the estimated dates of completion of the several parts, and important milestones within the several parts.

Section 3 - Familiarity with Work

The Bidder or its representative shall make personal investigations of the site of the work and of existing structures and shall determine to its own satisfaction the conditions to be encountered, the nature of the ground, the difficulties involved, and all other factors affecting the work proposed under this Contract. The Bidder to whom this Contract is awarded will not be entitled to any additional compensation unless conditions are clearly different from those which could reasonably have been anticipated by a person making diligent and thorough investigation of the site.

The Bidder shall immediately notify the City upon discovery, and in every case prior to submitting its Bid, of every error or omission in the bidding documents that would be identified by a reasonably competent, diligent Bidder. In no case will a Bidder be allowed the benefit of extra compensation or time to complete the work under this Contract for extra expenses or time spent as a result of the error or omission.

Section 4 - Wage Requirements

Under this Contract, the Contractor shall conform to Chapter 14 of Title I of the Code of the City of Ann Arbor as amended; which in part states "...that all craftsmen, mechanics and laborers employed directly on the site in connection with said improvements, including said employees of subcontractors, shall receive the prevailing wage for the corresponding classes of craftsmen,

mechanics and laborers, as determined by statistics for the Ann Arbor area compiled by the United States Department of Labor. At the request of the City, any contractor or subcontractor shall provide satisfactory proof of compliance with the contract provisions required by the Section.

Pursuant to Resolution R-16-469 all public improvement contractors are subject to prevailing wage and will be required to provide to the City payroll records sufficient to demonstrate compliance with the prevailing wage requirements. A sample Prevailing Wage Form is provided in the Appendix herein for reference as to what will be expected from contractors. Use of the Prevailing Wage Form provided in the Appendix section or a City-approved equivalent will be required along with wage rate interviews.

Where the Contract and the Ann Arbor City Ordinance are silent as to definitions of terms required in determining contract compliance with regard to prevailing wages, the definitions provided in the Davis-Bacon Act as amended (40 U.S.C. 278-a to 276-a-7) for the terms shall be used.

If the Contractor is a "covered employer" as defined in Chapter 23 of the Ann Arbor City Code, the Contractor agrees to comply with the living wage provisions of Chapter 23 of the Ann Arbor City Code. The Contractor agrees to pay those employees providing Services to the City under this Agreement a "living wage," as defined in Section 1:815 of the Ann Arbor City Code, as adjusted in accordance with Section 1:815(3); to post a notice approved by the City of the applicability of Chapter 23 in every location in which regular or contract employees providing services under this Agreement are working; to maintain records of compliance; if requested by the City, to provide documentation to verify compliance; to take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee or person contracted for employment in order to pay the living wage required by Section 1:815; and otherwise to comply with the requirements of Chapter 23.

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision covering subcontractor's employees who perform work on this contract.

Section 5 - Non-Discrimination

The Contractor agrees to comply, and to require its subcontractor(s) to comply, with the nondiscrimination provisions of MCL 37.2209. The Contractor further agrees to comply with the provisions of Section 9:158 of Chapter 112 of Title IX of the Ann Arbor City Code, and to assure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity.

Section 6 - Materials, Appliances, Employees

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation, and other facilities necessary or used for the execution and completion of the work. Unless otherwise specified, all materials incorporated in the permanent work shall be new, and both workmanship and materials shall be of the highest quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

The Contractor shall at all times enforce strict discipline and good order among its employees and shall seek to avoid employing on the work any unfit person or anyone not skilled in the work assigned.

Adequate sanitary facilities shall be provided by the Contractor.

Section 7 - Qualifications for Employment

The Contractor shall employ competent laborers and mechanics for the work under this Contract. For work performed under this Contract, employment preference shall be given to qualified local residents.

Section 8 - Royalties and Patents

The Contractor shall pay all royalties and license fees. It shall defend all suits or claims for infringements of any patent rights and shall hold the City harmless from loss on account of infringement except that the City shall be responsible for all infringement loss when a particular process or the product of a particular manufacturer or manufacturers is specified, unless the City has notified the Contractor prior to the signing of the Contract that the particular process or product is patented or is believed to be patented.

Section 9 - Permits and Regulations

The Contractor must secure and pay for all permits, permit or plan review fees and licenses necessary for the prosecution of the work. These include but are not limited to City building permits, right-of-way permits, lane closure permits, right-of-way occupancy permits, and the like. The City shall secure and pay for easements shown on the plans unless otherwise specified.

The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the contract documents are at variance with those requirements, it shall promptly notify the Supervising Professional in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the work.

Section 10 - Protection of the Public and of Work and Property

The Contractor is responsible for the means, methods, sequences, techniques and procedures of construction and safety programs associated with the work contemplated by this contract. The Contractor, its agents or sub-contractors, shall comply with the "General Rules and Regulations for the Construction Industry" as published by the Construction Safety Commission of the State of Michigan and to all other local, State and National laws, ordinances, rules and regulations pertaining to safety of persons and property.

The Contractor shall take all necessary and reasonable precautions to protect the safety of the public. It shall continuously maintain adequate protection of all work from damage, and shall take all necessary and reasonable precautions to adequately protect all public and private property from injury or loss arising in connection with this Contract. It shall make good any damage, injury or loss to its work and to public and private property resulting from lack of reasonable protective precautions, except as may be due to errors in the contract documents, or caused by agents or employees of the City. The Contractor shall obtain and maintain sufficient insurance to cover damage to any City property at the site by any cause.

In an emergency affecting the safety of life, or the work, or of adjoining property, the Contractor is, without special instructions or authorization from the Supervising Professional, permitted to act at its discretion to prevent the threatened loss or injury. It shall also so act, without appeal, if authorized or instructed by the Supervising Professional.

Any compensation claimed by the Contractor for emergency work shall be determined by agreement or in accordance with the terms of Claims for Extra Cost - Section 15.

Section 11 - Inspection of Work

The City shall provide sufficient competent personnel for the inspection of the work.

The Supervising Professional shall at all times have access to the work whenever it is in preparation or progress, and the Contractor shall provide proper facilities for access and for inspection.

If the specifications, the Supervising Professional's instructions, laws, ordinances, or any public authority require any work to be specially tested or approved, the Contractor shall give the Supervising Professional timely notice of its readiness for inspection, and if the inspection is by an authority other than the Supervising Professional, of the date fixed for the inspection. Inspections by the Supervising Professional shall be made promptly, and where practicable at the source of supply. If any work should be covered up without approval or consent of the Supervising Professional, it must, if required by the Supervising Professional, be uncovered for examination and properly restored at the Contractor's expense.

Re-examination of any work may be ordered by the Supervising Professional, and, if so ordered, the work must be uncovered by the Contractor. If the work is found to be in accordance with the contract documents, the City shall pay the cost of re-examination and replacement. If the work is not in accordance with the contract documents, the Contractor shall pay the cost.

Section 12 - Superintendence

The Contractor shall keep on the work site, during its progress, a competent superintendent and any necessary assistants, all satisfactory to the Supervising Professional. The superintendent will be responsible to perform all on-site project management for the Contractor. The superintendent shall be experienced in the work required for this Contract. The superintendent shall represent the Contractor and all direction given to the superintendent shall be binding as if given to the Contractor. Important directions shall immediately be confirmed in writing to the Contractor. Other directions will be confirmed on written request. The Contractor shall give efficient superintendence to the work, using its best skill and attention.

Section 13 - Changes in the Work

The City may make changes to the quantities of work within the general scope of the Contract at any time by a written order and without notice to the sureties. If the changes add to or deduct from the extent of the work, the Contract Sum shall be adjusted accordingly. All the changes shall be executed under the conditions of the original Contract except that any claim for extension of time caused by the change shall be adjusted at the time of ordering the change.

In giving instructions, the Supervising Professional shall have authority to make minor changes in the work not involving extra cost and not inconsistent with the purposes of the work, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Supervising Professional, and no claim for an addition to the Contract Sum shall be valid unless the additional work was ordered in writing.

The Contractor shall proceed with the work as changed and the value of the work shall be determined as provided in Claims for Extra Cost - Section 15.

Section 14 - Extension of Time

Extension of time stipulated in the Contract for completion of the work will be made if and as the Supervising Professional may deem proper under any of the following circumstances:

- (1) When work under an extra work order is added to the work under this Contract;
- (2) When the work is suspended as provided in Section 20;
- (3) When the work of the Contractor is delayed on account of conditions which could not have been foreseen, or which were beyond the control of the Contractor, and which were not the result of its fault or negligence;
- (4) Delays in the progress of the work caused by any act or neglect of the City or of its employees or by other Contractors employed by the City;
- (5) Delay due to an act of Government;
- (6) Delay by the Supervising Professional in the furnishing of plans and necessary information;
- (7) Other cause which in the opinion of the Supervising Professional entitles the Contractor to an extension of time.

The Contractor shall notify the Supervising Professional within 7 days of an occurrence or conditions which, in the Contractor's opinion, entitle it to an extension of time. The notice shall be in writing and submitted in ample time to permit full investigation and evaluation of the Contractor's claim. The Supervising Professional shall acknowledge receipt of the Contractor's notice within 7 days of its receipt. Failure to timely provide the written notice shall constitute a waiver by the Contractor of any claim.

In situations where an extension of time in contract completion is appropriate under this or any other section of the contract, the Contractor understands and agrees that the only available adjustment for events that cause any delays in contract completion shall be extension of the required time for contract completion and that there shall be no adjustments in the money due the Contractor on account of the delay.

Section 15 - Claims for Extra Cost

If the Contractor claims that any instructions by drawings or other media issued after the date of the Contract involved extra cost under this Contract, it shall give the Supervising Professional written notice within 7 days after the receipt of the instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property. The procedure shall then be as provided for Changes in the Work-Section I3. No claim shall be valid unless so made.

If the Supervising Professional orders, in writing, the performance of any work not covered by the contract documents, and for which no item of work is provided in the Contract, and for which no unit price or lump sum basis can be agreed upon, then the extra work shall be done on a Cost-Plus-Percentage basis of payment as follows:

- (1) The Contractor shall be reimbursed for all reasonable costs incurred in doing the work, and shall receive an additional payment of 15% of all the reasonable costs to cover both its indirect overhead costs and profit;
- (2) The term "Cost" shall cover all payroll charges for employees and supervision required under the specific order, together with all worker's compensation, Social Security, pension and retirement allowances and social insurance, or other regular payroll charges on same; the cost of all material and supplies required of either temporary or permanent character;

rental of all power-driven equipment at agreed upon rates, together with cost of fuel and supply charges for the equipment; and any costs incurred by the Contractor as a direct result of executing the order, if approved by the Supervising Professional;

- (3) If the extra is performed under subcontract, the subcontractor shall be allowed to compute its charges as described above. The Contractor shall be permitted to add an additional charge of 5% percent to that of the subcontractor for the Contractor's supervision and contractual responsibility;
- (4) The quantities and items of work done each day shall be submitted to the Supervising Professional in a satisfactory form on the succeeding day, and shall be approved by the Supervising Professional and the Contractor or adjusted at once;
- (5) Payments of all charges for work under this Section in any one month shall be made along with normal progress payments. Retainage shall be in accordance with Progress Payments-Section 16.

No additional compensation will be provided for additional equipment, materials, personnel, overtime or special charges required to perform the work within the time requirements of the Contract.

When extra work is required and no suitable price for machinery and equipment can be determined in accordance with this Section, the hourly rate paid shall be 1/40 of the basic weekly rate listed in the Rental Rate Blue Book published by Dataquest Incorporated and applicable to the time period the equipment was first used for the extra work. The hourly rate will be deemed to include all costs of operation such as bucket or blade, fuel, maintenance, "regional factors", insurance, taxes, and the like, but not the costs of the operator.

Section 16 - Progress Payments

The Contractor shall submit each month, or at longer intervals, if it so desires, an invoice covering work performed for which it believes payment, under the Contract terms, is due. The submission shall be to the City's Finance Department - Accounting Division. The Supervising Professional will, within 10 days following submission of the invoice, prepare a certificate for payment for the work in an amount to be determined by the Supervising Professional as fairly representing the acceptable work performed during the period covered by the Contractor's invoice. To insure the proper performance of this Contract, the City will retain a percentage of the estimate in accordance with Act 524, Public Acts of 1980. The City will then, following the receipt of the Supervising Professional's Certificate, make payment to the Contractor as soon as feasible, which is anticipated will be within 15 days.

An allowance may be made in progress payments if substantial quantities of permanent material have been delivered to the site but not incorporated in the completed work if the Contractor, in the opinion of the Supervising Professional, is diligently pursuing the work under this Contract. Such materials shall be properly stored and adequately protected. Allowance in the estimate shall be at the invoice price value of the items. Notwithstanding any payment of any allowance, all risk of loss due to vandalism or any damages to the stored materials remains with the Contractor.

In the case of Contracts which include only the Furnishing and Delivering of Equipment, the payments shall be; 60% of the Contract Sum upon the delivery of all equipment to be furnished, or in the case of delivery of a usable portion of the equipment in advance of the total equipment delivery, 60% of the estimated value of the portion of the equipment may be paid upon its delivery in advance of the time of the remainder of the equipment to be furnished; 30% of the Contract Sum upon completion of erection of all equipment furnished, but not later than 60 days after the

date of delivery of all of the equipment to be furnished; and payment of the final 10% on final completion of erection, testing and acceptance of all the equipment to be furnished; but not later than 180 days after the date of delivery of all of the equipment to be furnished, unless testing has been completed and shows the equipment to be unacceptable.

With each invoice for periodic payment, the Contractor shall enclose a Contractor's Declaration - Section 43, and an updated project schedule per Order of Completion - Section 2.

Section 17 - Deductions for Uncorrected Work

If the Supervising Professional decides it is inexpedient to correct work that has been damaged or that was not done in accordance with the Contract, an equitable deduction from the Contract price shall be made.

Section 18 - Correction of Work Before Final Payment

The Contractor shall promptly remove from the premises all materials condemned by the Supervising Professional as failing to meet Contract requirements, whether incorporated in the work or not, and the Contractor shall promptly replace and re-execute the work in accordance with the Contract and without expense to the City and shall bear the expense of making good all work of other contractors destroyed or damaged by the removal or replacement.

If the Contractor does not remove the condemned work and materials within 10 days after written notice, the City may remove them and, if the removed material has value, may store the material at the expense of the Contractor. If the Contractor does not pay the expense of the removal within 10 days thereafter, the City may, upon 10 days written notice, sell the removed materials at auction or private sale and shall pay to the Contractor the net proceeds, after deducting all costs and expenses that should have been borne by the Contractor. If the removed material has no value, the Contractor must pay the City the expenses for disposal within 10 days of invoice for the disposal costs.

The inspection or lack of inspection of any material or work pertaining to this Contract shall not relieve the Contractor of its obligation to fulfill this Contract and defective work shall be made good. Unsuitable materials may be rejected by the Supervising Professional notwithstanding that the work and materials have been previously overlooked by the Supervising Professional and accepted or estimated for payment or paid for. If the work or any part shall be found defective at any time before the final acceptance of the whole work, the Contractor shall forthwith make good the defect in a manner satisfactory to the Supervising Professional. The judgment and the decision of the Supervising Professional as to whether the materials supplied and the work done under this Contract comply with the requirements of the Contract shall be conclusive and final.

Section 19 - Acceptance and Final Payment

Upon receipt of written notice that the work is ready for final inspection and acceptance, the Supervising Professional will promptly make the inspection. When the Supervising Professional finds the work acceptable under the Contract and the Contract fully performed, the Supervising Professional will promptly sign and issue a final certificate stating that the work required by this Contract has been completed and is accepted by the City under the terms and conditions of the Contract. The entire balance found to be due the Contractor, including the retained percentage, shall be paid to the Contractor by the City within 30 days after the date of the final certificate.

Before issuance of final certificates, the Contractor shall file with the City:

- (1) The consent of the surety to payment of the final estimate;

- (2) The Contractor's Affidavit in the form required by Section 44.

In case the Affidavit or consent is not furnished, the City may retain out of any amount due the Contractor, sums sufficient to cover all lienable claims.

The making and acceptance of the final payment shall constitute a waiver of all claims by the City except those arising from:

- (1) unsettled liens;
- (2) faulty work appearing within 12 months after final payment;
- (3) hidden defects in meeting the requirements of the plans and specifications;
- (4) manufacturer's guarantees.

It shall also constitute a waiver of all claims by the Contractor, except those previously made and still unsettled.

Section 20 - Suspension of Work

The City may at any time suspend the work, or any part by giving 5 days notice to the Contractor in writing. The work shall be resumed by the Contractor within 10 days after the date fixed in the written notice from the City to the Contractor to do so. The City shall reimburse the Contractor for expense incurred by the Contractor in connection with the work under this Contract as a result of the suspension.

If the work, or any part, shall be stopped by the notice in writing, and if the City does not give notice in writing to the Contractor to resume work at a date within 90 days of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work suspended and will be entitled to the estimates and payments for all work done on the portions abandoned, if any, plus 10% of the value of the work abandoned, to compensate for loss of overhead, plant expense, and anticipated profit.

Section 21 - Delays and the City's Right to Terminate Contract

If the Contractor refuses or fails to prosecute the work, or any separate part of it, with the diligence required to insure completion, ready for operation, within the allowable number of consecutive calendar days specified plus extensions, or fails to complete the work within the required time, the City may, by written notice to the Contractor, terminate its right to proceed with the work or any part of the work as to which there has been delay. After providing the notice the City may take over the work and prosecute it to completion, by contract or otherwise, and the Contractor and its sureties shall be liable to the City for any excess cost to the City. If the Contractor's right to proceed is terminated, the City may take possession of and utilize in completing the work, any materials, appliances and plant as may be on the site of the work and useful for completing the work. The right of the Contractor to proceed shall not be terminated or the Contractor charged with liquidated damages where an extension of time is granted under Extension of Time - Section 14.

If the Contractor is adjudged a bankrupt, or if it makes a general assignment for the benefit of creditors, or if a receiver is appointed on account of its insolvency, or if it persistently or repeatedly refuses or fails except in cases for which extension of time is provided, to supply enough properly skilled workers or proper materials, or if it fails to make prompt payments to subcontractors or for material or labor, or persistently disregards laws, ordinances or the instructions of the Supervising Professional, or otherwise is guilty of a substantial violation of any provision of the Contract, then the City, upon the certificate of the Supervising Professional that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Contractor 3

days written notice, terminate this Contract. The City may then take possession of the premises and of all materials, tools and appliances thereon and without prejudice to any other remedy it may have, make good the deficiencies or finish the work by whatever method it may deem expedient, and deduct the cost from the payment due the Contractor. The Contractor shall not be entitled to receive any further payment until the work is finished. If the expense of finishing the work, including compensation for additional managerial and administrative services exceeds the unpaid balance of the Contract Sum, the Contractor and its surety are liable to the City for any excess cost incurred. The expense incurred by the City, and the damage incurred through the Contractor's default, shall be certified by the Supervising Professional.

Section 22 - Contractor's Right to Terminate Contract

If the work should be stopped under an order of any court, or other public authority, for a period of 3 months, through no act or fault of the Contractor or of anyone employed by it, then the Contractor may, upon 7 days written notice to the City, terminate this Contract and recover from the City payment for all acceptable work executed plus reasonable profit.

Section 23 - City's Right To Do Work

If the Contractor should neglect to prosecute the work properly or fail to perform any provision of this Contract, the City, 3 days after giving written notice to the Contractor and its surety may, without prejudice to any other remedy the City may have, make good the deficiencies and may deduct the cost from the payment due to the Contractor.

Section 24 - Removal of Equipment and Supplies

In case of termination of this Contract before completion, from any or no cause, the Contractor, if notified to do so by the City, shall promptly remove any part or all of its equipment and supplies from the property of the City, failing which the City shall have the right to remove the equipment and supplies at the expense of the Contractor.

The removed equipment and supplies may be stored by the City and, if all costs of removal and storage are not paid by the Contractor within 10 days of invoicing, the City upon 10 days written notice may sell the equipment and supplies at auction or private sale, and shall pay the Contractor the net proceeds after deducting all costs and expenses that should have been borne by the Contractor and after deducting all amounts claimed due by any lien holder of the equipment or supplies.

Section 25 - Responsibility for Work and Warranties

The Contractor assumes full responsibility for any and all materials and equipment used in the construction of the work and may not make claims against the City for damages to materials and equipment from any cause except negligence or willful act of the City. Until its final acceptance, the Contractor shall be responsible for damage to or destruction of the project (except for any part covered by Partial Completion and Acceptance - Section 26). The Contractor shall make good all work damaged or destroyed before acceptance. All risk of loss remains with the Contractor until final acceptance of the work (Section 19) or partial acceptance (Section 26). The Contractor is advised to investigate obtaining its own builders risk insurance.

The Contractor shall guarantee the quality of the work for a period of one year. The Contractor shall also unconditionally guarantee the quality of all equipment and materials that are furnished and installed under the contract for a period of one year. At the end of one year after the Contractor's receipt of final payment, the complete work, including equipment and materials furnished and installed under the contract, shall be inspected by the Contractor and the

Supervising Professional. Any defects shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. Any defects that are identified prior to the end of one year shall also be inspected by the Contractor and the Supervising Professional and shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. The Contractor shall assign all manufacturer or material supplier warranties to the City prior to final payment. The assignment shall not relieve the Contractor of its obligations under this paragraph to correct defects.

Section 26 - Partial Completion and Acceptance

If at any time prior to the issuance of the final certificate referred to in Acceptance and Final Payment - Section 19, any portion of the permanent construction has been satisfactorily completed, and if the Supervising Professional determines that portion of the permanent construction is not required for the operations of the Contractor but is needed by the City, the Supervising Professional shall issue to the Contractor a certificate of partial completion, and immediately the City may take over and use the portion of the permanent construction described in the certificate, and exclude the Contractor from that portion.

The issuance of a certificate of partial completion shall not constitute an extension of the Contractor's time to complete the portion of the permanent construction to which it relates if the Contractor has failed to complete it in accordance with the terms of this Contract. The issuance of the certificate shall not release the Contractor or its sureties from any obligations under this Contract including bonds.

If prior use increases the cost of, or delays the work, the Contractor shall be entitled to extra compensation, or extension of time, or both, as the Supervising Professional may determine.

Section 27 - Payments Withheld Prior to Final Acceptance of Work

The City may withhold or, on account of subsequently discovered evidence, nullify the whole or part of any certificate to the extent reasonably appropriate to protect the City from loss on account of:

- (1) Defective work not remedied;
- (2) Claims filed or reasonable evidence indicating probable filing of claims by other parties against the Contractor;
- (3) Failure of the Contractor to make payments properly to subcontractors or for material or labor;
- (4) Damage to another Contractor.

When the above grounds are removed or the Contractor provides a Surety Bond satisfactory to the City which will protect the City in the amount withheld, payment shall be made for amounts withheld under this section.

Section 28 - Contractor's Insurance

- (1) The Contractor shall procure and maintain during the life of this Contract, including the guarantee period and during any warranty work, such insurance policies, including those set forth below, as will protect itself and the City from all claims for bodily injuries, death or property damage which may arise under this Contract; whether the act(s) or omission(s)

giving rise to the claim were made by the Contractor or by any subcontractor or anyone employed by them directly or indirectly. In the case of all contracts involving on-site work, the Contractor shall provide to the City, before the commencement of any work under this contract, certificates of insurance and other documentation satisfactory to the City demonstrating it has obtained the policies and endorsements required. On behalf of itself, and when requested, any subcontractor(s). The certificates of insurance endorsements and/or copies of policy language shall document that the Contractor satisfies the following minimum requirements.

- (a) Worker's Compensation Insurance in accordance with all applicable state and federal statutes. Further, Employers Liability Coverage shall be obtained in the following minimum amounts:

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

- (b) Commercial General Liability Insurance equivalent to, as a minimum, Insurance Services Office form CG 00 01 07 98 or current equivalent. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements specifically for the following coverages: Products and Completed Operations, Explosion, Collapse and Underground coverage or Pollution. Further there shall be no added exclusions or limiting endorsements which diminish the City's protections as an additional insured under the policy. The following minimum limits of liability are required:

\$1,000,000 Each occurrence as respect Bodily Injury Liability or Property
Damage Liability, or both combined.
\$2,000,000 Per Job General Aggregate
\$1,000,000 Personal and Advertising Injury
\$2,000,000 Products and Completed Operations Aggregate

- (c) Motor Vehicle Liability Insurance, including Michigan No-Fault Coverages, equivalent to, as a minimum, Insurance Services Office form CA 00 01 07 97 or current equivalent. Coverage shall include all owned vehicles, all non-owned vehicles and all hired vehicles. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements which diminish the City's protections as an additional insured under the policy. Further, the limits of liability shall be \$1,000,000 for each occurrence as respects Bodily Injury Liability or Property Damage Liability, or both combined.

- (d) Umbrella/Excess Liability Insurance shall be provided to apply excess of the Commercial General Liability, Employers Liability and the Motor Vehicle coverage enumerated above, for each occurrence and for aggregate in the amount of \$1,000,000.

- (2) Insurance required under subsection (1)(b) and (1)(c) above shall be considered primary as respects any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute with this insurance. Further, the Contractor agrees to waive any right of recovery by its insurer against the City.
- (3) Insurance companies and policy forms are subject to approval of the City Attorney, which approval shall not be unreasonably withheld. Documentation must provide and

demonstrate an unconditional 30 day written notice of cancellation in favor of the City of Ann Arbor. Further, the documentation must explicitly state the following: (a) the policy number; name of insurance company; name and address of the agent or authorized representative; name and address of insured; project name; policy expiration date; and specific coverage amounts; (b) any deductibles or self-insured retentions which shall be approved by the City, in its sole discretion; (c) that the policy conforms to the requirements specified Contractor shall furnish the City with satisfactory certificates of insurance and endorsements prior to commencement of any work. Upon request, the Contractor shall provide within 30 days a copy of the policy(ies) to the City. If any of the above coverages expire by their terms during the term of this Contract, the Contractor shall deliver proof of renewal and/or new policies and endorsements to the Administering Service Area/Unit at least ten days prior to the expiration date.

- (4) Any Insurance provider of Contractor shall be admitted and authorized to do business in the State of Michigan and shall carry and maintain a minimum rating assigned by A.M. Best & Company's Key Rating Guide of "A-" Overall and a minimum Financial Size Category of "V". Insurance policies and certificates issued by non-admitted insurance companies are not acceptable unless approved in writing by the City.
- (5) City reserves the right to require additional coverage and/or coverage amounts as may be included from time to time in the Detailed Specifications for the Project.
- (6) The provisions of General Condition 28 shall survive the expiration or earlier termination of this contract for any reason.

Section 29 - Surety Bonds

Bonds will be required from the successful bidder as follows:

- (1) A Performance Bond to the City of Ann Arbor for the amount of the bid(s) accepted;
- (2) A Labor and Material Bond to the City of Ann Arbor for the amount of the bid(s) accepted.

Bonds shall be executed on forms supplied by the City in a manner and by a Surety Company authorized to transact business in Michigan and satisfactory to the City Attorney.

Section 30 - Damage Claims

The Contractor shall be held responsible for all damages to property of the City or others, caused by or resulting from the negligence of the Contractor, its employees, or agents during the progress of or connected with the prosecution of the work, whether within the limits of the work or elsewhere. The Contractor must restore all property injured including sidewalks, curbing, sodding, pipes, conduit, sewers or other public or private property to not less than its original condition with new work.

Section 31 - Refusal to Obey Instructions

If the Contractor refuses to obey the instructions of the Supervising Professional, the Supervising Professional shall withdraw inspection from the work, and no payments will be made for work performed thereafter nor may work be performed thereafter until the Supervising Professional shall have again authorized the work to proceed.

Section 32 - Assignment

Neither party to the Contract shall assign the Contract without the written consent of the other. The Contractor may assign any monies due to it to a third party acceptable to the City.

Section 33 - Rights of Various Interests

Whenever work being done by the City's forces or by other contractors is contiguous to work covered by this Contract, the respective rights of the various interests involved shall be established by the Supervising Professional, to secure the completion of the various portions of the work in general harmony.

The Contractor is responsible to coordinate all aspects of the work, including coordination of, and with, utility companies and other contractors whose work impacts this project.

Section 34 - Subcontracts

The Contractor shall not award any work to any subcontractor without prior written approval of the City. The approval will not be given until the Contractor submits to the City a written statement concerning the proposed award to the subcontractor. The statement shall contain all information the City may require.

The Contractor shall be as fully responsible to the City for the acts and omissions of its subcontractors, and of persons either directly or indirectly employed by them, as it is for the acts and omissions of persons directly employed by it.

The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractors to the Contractor by the terms of the General Conditions and all other contract documents applicable to the work of the subcontractors and to give the Contractor the same power to terminate any subcontract that the City may exercise over the Contractor under any provision of the contract documents.

Nothing contained in the contract documents shall create any contractual relation between any subcontractor and the City.

Section 35 - Supervising Professional's Status

The Supervising Professional has the right to inspect any or all work. The Supervising Professional has authority to stop the work whenever stoppage may be appropriate to insure the proper execution of the Contract. The Supervising Professional has the authority to reject all work and materials which do not conform to the Contract and to decide questions which arise in the execution of the work.

The Supervising Professional shall make all measurements and determinations of quantities. Those measurements and determinations are final and conclusive between the parties.

Section 36 - Supervising Professional's Decisions

The Supervising Professional shall, within a reasonable time after their presentation to the Supervising Professional, make decisions in writing on all claims of the City or the Contractor and on all other matters relating to the execution and progress of the work or the interpretation of the contract documents.

Section 37 - Storing Materials and Supplies

Materials and supplies may be stored at the site of the work at locations agreeable to the City unless specific exception is listed elsewhere in these documents. Ample way for foot traffic and drainage must be provided, and gutters must, at all times, be kept free from obstruction. Traffic on streets shall be interfered with as little as possible. The Contractor may not enter or occupy with agents, employees, tools, or material any private property without first obtaining written permission from its owner. A copy of the permission shall be furnished to the Supervising Professional.

Section 38 - Lands for Work

The Contractor shall provide, at its own expense and without liability to the City, any additional land and access that may be required for temporary construction facilities or for storage of materials.

Section 39 - Cleaning Up

The Contractor shall, as directed by the Supervising Professional, remove at its own expense from the City's property and from all public and private property all temporary structures, rubbish and waste materials resulting from its operations unless otherwise specifically approved, in writing, by the Supervising Professional.

Section 40 - Salvage

The Supervising Professional may designate for salvage any materials from existing structures or underground services. Materials so designated remain City property and shall be transported or stored at a location as the Supervising Professional may direct.

Section 41 - Night, Saturday or Sunday Work

No night or Sunday work (without prior written City approval) will be permitted except in the case of an emergency and then only to the extent absolutely necessary. The City may allow night work which, in the opinion of the Supervising Professional, can be satisfactorily performed at night. Night work is any work between 8:00 p.m. and 7:00 a.m. No Saturday work will be permitted unless the Contractor gives the Supervising Professional at least 48 hours but not more than 5 days notice of the Contractor's intention to work the upcoming Saturday.

Section 42 - Sales Taxes

Under State law the City is exempt from the assessment of State Sales Tax on its direct purchases. Contractors who acquire materials, equipment, supplies, etc. for incorporation in City projects are not likewise exempt. State Law shall prevail. The Bidder shall familiarize itself with the State Law and prepare its Bid accordingly. No extra payment will be allowed under this Contract for failure of the Contractor to make proper allowance in this bid for taxes it must pay.

Section 43

CONTRACTOR'S DECLARATION

I hereby declare that I have not, during the period _____, 20____, to _____, 20____, performed any work, furnished any materials, sustained any loss, damage or delay, or otherwise done anything in addition to the regular items (or executed change orders) set forth in the Contract titled _____, for which I shall ask, demand, sue for, or claim compensation or extension of time from the City, except as I hereby make claim for additional compensation or extension of time as set forth on the attached itemized statement. I further declare that I have paid all payroll obligations related to this Contract that have become due during the above period and that all invoices related to this Contract received more than 30 days prior to this declaration have been paid in full except as listed below.

There is/is not (Contractor please circle one and strike one as appropriate) an itemized statement attached regarding a request for additional compensation or extension of time.

Contractor

Date

By _____
(Signature)

Its _____
(Title of Office)

Past due invoices, if any, are listed below.

SUPPLEMENTAL GENERAL CONDITIONS

General Safety Requirements

The Contractor shall be responsible for ensuring compliance with the most stringent provisions of the applicable statutes and regulations of the Michigan Occupational Safety and Health Act 154 of 1974, the Occupational Safety and Health Act of 1970, and all City of Ann Arbor safety policies. The Contractor shall flow down all these requirements to any subcontractors performing work under the contract. Should charges of violation of any of the above be issued to the Contractor in the course of the work, a copy of each charge shall be immediately forwarded to the City along with a plan to correct the violation.

Upon the failure of the Contractor to comply with any of these requirements, the City's Representative shall have the authority to stop any and all operations of the Contractor affected by such failure until such failure is remedied. No part of the time lost due to any such stop orders shall be made subject to a claim or extension of time or increase in compensation.

All materials, equipment, and supplies provided to the City of Ann Arbor must comply fully with all safety requirements as set forth by the Michigan Occupational Safety and Health act 154 of 1974 and all applicable OSHA Standards.

STANDARD SPECIFICATIONS

All work under this contract shall be performed in accordance with the Public Services Department Standard Specifications in effect at the date of availability of the contract documents stipulated in the Bid. All work under this Contract which is not included in these Standard Specifications, or which is performed using modifications to these Standard Specifications, shall be performed in accordance with the Detailed Specifications included in these contract documents.

Standard Specifications are available online:

<http://www.a2gov.org/departments/engineering/Pages/Engineering-and-Contractor-Resources.aspx>

DETAILED SPECIFICATIONS

ATTACHMENTS

CITY OF ANN ARBOR
LIVING WAGE ORDINANCE DECLARATION OF COMPLIANCE

The Ann Arbor Living Wage Ordinance (Section 1:811-1:821 of Chapter 23 of Title I of the Code) requires that an employer who is (a) a contractor providing services to or for the City for a value greater than \$10,000 for any twelve-month contract term, or (b) a recipient of federal, state, or local grant funding administered by the City for a value greater than \$10,000, or (c) a recipient of financial assistance awarded by the City for a value greater than \$10,000, shall pay its employees a prescribed minimum level of compensation (i.e., Living Wage) for the time those employees perform work on the contract or in connection with the grant or financial assistance. The Living Wage must be paid to these employees for the length of the contract/program.

Companies employing fewer than 5 persons and non-profits employing fewer than 10 persons are exempt from compliance with the Living Wage Ordinance. If this exemption applies to your company/non-profit agency please check here No. of employees__

The Contractor or Grantee agrees:

- (a) To pay each of its employees whose wage level is not required to comply with federal, state or local prevailing wage law, for work covered or funded by a contract with or grant from the City, no less than the Living Wage. The current Living Wage is defined as \$13.22/hour for those employers that provide employee health care (as defined in the Ordinance at Section 1:815 Sec. 1 (a)), or no less than \$14.75/hour for those employers that do not provide health care. The Contractor or Grantor understands that the Living Wage is adjusted and established annually on April 30 in accordance with the Ordinance and covered employers shall be required to pay the adjusted amount thereafter to be in compliance with Section 1:815(3).

Check the applicable box below which applies to your workforce

Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage without health benefits

Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage with health benefits

- (a) To post a notice approved by the City regarding the applicability of the Living Wage Ordinance in every work place or other location in which employees or other persons contracting for employment are working.
- (b) To provide to the City payroll records or other documentation within ten (10) business days from the receipt of a request by the City.
- (c) To permit access to work sites to City representatives for the purposes of monitoring compliance, and investigating complaints or non-compliance.
- (d) To take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee covered by the Living Wage Ordinance or any person contracted for employment and covered by the Living Wage Ordinance in order to pay the living wage required by the Living Wage Ordinance.

The undersigned states that he/she has the requisite authority to act on behalf of his/her employer in these matters and has offered to provide the services or agrees to accept financial assistance in accordance with the terms of the Living Wage Ordinance. The undersigned certifies that he/she has read and is familiar with the terms of the Living Wage Ordinance, obligates the Employer/Grantee to those terms and acknowledges that if his/her employer is found to be in violation of Ordinance it may be subject to civil penalties and termination of the awarded contract or grant of financial assistance.

Company Name

Street Address

Signature of Authorized Representative

Date

City, State, Zip

Print Name and Title

Phone/Email address

CITY OF ANN ARBOR LIVING WAGE ORDINANCE

RATE EFFECTIVE APRIL 30, 2018 - ENDING APRIL 29, 2019

\$13.22 per hour

If the employer provides health care benefits*

\$14.75 per hour

If the employer does **NOT** provide health care benefits*

Employers providing services to or for the City of Ann Arbor or recipients of grants or financial assistance from the City of Ann Arbor for a value of more than \$10,000 in a twelve-month period of time must pay those employees performing work on a City of Ann Arbor contract or grant, the above living wage.

ENFORCEMENT

The City of Ann Arbor may recover back wages either administratively or through court action for the employees that have been underpaid in violation of the law. Persons denied payment of the living wage have the right to bring a civil action for damages in addition to any action taken by the City.

Violation of this Ordinance is punishable by fines of not more than \$500/violation plus costs, with each day being considered a separate violation. Additionally, the City of Ann Arbor has the right to modify, terminate, cancel or suspend a contract in the event of a violation of the Ordinance.

* Health Care benefits include those paid for by the employer or making an employer contribution toward the purchase of health care. The employee contribution must not exceed \$.50 an hour for an average work week; and the employer cost or contribution must equal no less than \$1/hr for the average work week.

The Law Requires Employers to Display This Poster Where Employees Can Readily See It.

**For Additional Information or to File a Complaint Contact:
Colin Spencer at 734/794-6500 or cspencer@a2gov.org**



Vendor Conflict of Interest Disclosure Form
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All vendors interested in conducting business with the City of Ann Arbor must complete and return the Vendor Conflict of Interest Disclosure Form in order to be eligible to be awarded a contract. Please note that all vendors are subject to comply with the City of Ann Arbor’s conflict of interest policies as stated within the certification section below.

If a vendor has a relationship with a City of Ann Arbor official or employee, an immediate family member of a City of Ann Arbor official or employee, the vendor shall disclose the information required below.

1. No City official or employee or City employee’s immediate family member has an ownership interest in vendor’s company or is deriving personal financial gain from this contract.
2. No retired or separated City official or employee who has been retired or separated from the City for less than one (1) year has an ownership interest in vendor’s Company.
3. No City employee is contemporaneously employed or prospectively to be employed with the vendor.
4. Vendor hereby declares it has not and will not provide gifts or hospitality of any dollar value or any other gratuities to any City employee or elected official to obtain or maintain a contract.
5. Please note any exceptions below:

Conflict of Interest Disclosure*	
Name of City of Ann Arbor employees, elected officials or immediate family members with whom there may be a potential conflict of interest.	<input type="checkbox"/> Relationship to employee <hr style="border: 0; border-top: 1px solid black;"/> <input type="checkbox"/> Interest in vendor’s company <input type="checkbox"/> Other (please describe in box below)

*Disclosing a potential conflict of interest does not disqualify vendors. In the event vendors do not disclose potential conflicts of interest and they are detected by the City, vendor will be exempt from doing business with the City.

I certify that this Conflict of Interest Disclosure has been examined by me and that its contents are true and correct to my knowledge and belief and I have the authority to so certify on behalf of the Vendor by my signature below:		
Vendor Name	Vendor Phone Number	
Signature of Vendor Authorized Representative	Date	Printed Name of Vendor Authorized Representative

Questions about this form? Contact Procurement Office City of Ann Arbor Phone: 734/794-6500, procurement@a2gov.org

CITY OF ANN ARBOR NON-DISCRIMINATION ORDINANCE

Relevant provisions of Chapter 112, Nondiscrimination, of the Ann Arbor City Code are included below.

You can review the entire ordinance at www.a2gov.org/humanrights.

Intent: It is the intent of the city that no individual be denied equal protection of the laws; nor shall any individual be denied the enjoyment of his or her civil or political rights or be discriminated against because of actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight.

Discriminatory Employment Practices: No person shall discriminate in the hire, employment, compensation, work classifications, conditions or terms, promotion or demotion, or termination of employment of any individual. No person shall discriminate in limiting membership, conditions of membership or termination of membership in any labor union or apprenticeship program.

Discriminatory Effects: No person shall adopt, enforce or employ any policy or requirement which has the effect of creating unequal opportunities according to actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight for an individual to obtain housing, employment or public accommodation, except for a bona fide business necessity. Such a necessity does not arise due to a mere inconvenience or because of suspected objection to such a person by neighbors, customers or other persons.

Nondiscrimination by City Contractors: All contractors proposing to do business with the City of Ann Arbor shall satisfy the contract compliance administrative policy adopted by the City Administrator in accordance with the guidelines of this section. All city contractors shall ensure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity and tends to eliminate inequality based upon any classification protected by this chapter. All contractors shall agree not to discriminate against an employee or applicant for employment with respect to hire, tenure, terms, conditions, or privileges of employment, or a matter directly or indirectly related to employment, because of any applicable protected classification. All contractors shall be required to post a copy of Ann Arbor's Non-Discrimination Ordinance at all work locations where its employees provide services under a contract with the city.

Complaint Procedure: If any individual believes there has been a violation of this chapter, he/she may file a complaint with the City's Human Rights Commission. The complaint must be filed within 180 calendar days from the date of the individual's knowledge of the allegedly discriminatory action or 180 calendar days from the date when the individual should have known of the allegedly discriminatory action. A complaint that is not filed within this timeframe cannot be considered by the Human Rights Commission. To file a complaint, first complete the complaint form, which is available at www.a2gov.org/humanrights. Then submit it to the Human Rights Commission by e-mail (hrc@a2gov.org), by mail (Ann Arbor Human Rights Commission, PO Box 8647, Ann Arbor, MI 48107), or in person (City Clerk's Office). For further information, please call the commission at 734-794-6141 or e-mail the commission at hrc@a2gov.org.

Private Actions For Damages or Injunctive Relief: To the extent allowed by law, an individual who is the victim of discriminatory action in violation of this chapter may bring a civil action for appropriate injunctive relief or damages or both against the person(s) who acted in violation of this chapter.

THIS IS AN OFFICIAL GOVERNMENT NOTICE AND
MUST BE DISPLAYED WHERE EMPLOYEES CAN READILY SEE IT.

SECTION 01010

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SUMMARY OF WORK

- A. Work to be done includes the demolition, construction, startup, and testing of a new chiller system in the Ozone Building located in the Ann Arbor Water Treatment Plant. The project will include new chillers, piping, controls, condenser, and electrical equipment.
- B. The principal features of the Work to be performed under this Contract are:

SINGLE PRIME CONTRACT: Includes furnishing and installing equipment in the Ozone Building as described in the Contract Documents including the chiller systems and all related work.
- C. The foregoing description(s) shall not be construed as a complete description of all work required.

1.2 CONTRACT DOCUMENTS

- A. The Work to be done is shown on the set of Drawings entitled WTP Ozone Generation Building Chiller Replacement and dated August 2018. The numbers and titles of all Drawings appear on the cover sheet of the Drawings. All Drawings so enumerated shall be considered an integral part of the Contract Documents as defined herein.
- B. Certain Document Sections refer to Divisions of the Contract Specifications. Sections are each individually numbered portions of the Specifications (numerically) such as 08110, 13182, 15206, etc. The term Division is used as a convenience term meaning all Sections within a numerical grouping. Division 15 would thus include Sections 15010 through 15951.
- C. Where references in the Contract Documents are made to CONTRACTORS for specific disciplines of work (e.g. Electrical CONTRACTOR, etc.), these references shall be interpreted to be the single prime CONTRACTOR when the project is bid or awarded as a single prime Contract.
- D. The prime CONTRACTOR shall be responsible for all work in the Contract Documents regardless of the division of disciplines.
- E. ENGINEER shall provide the CONTRACTOR an electronic copy on CD of the Specifications and Contract Drawings. The CONTRACTOR shall be responsible for the production of his construction sets.

1.3 GENERAL ARRANGEMENT

- A. Drawings indicate the extent and general arrangement of the work. If any departures from the Drawings are deemed necessary by the CONTRACTOR to accommodate the materials and equipment CONTRACTOR proposes to furnish, details of such departures and reasons therefore shall be submitted as soon as practicable to the ENGINEER for approval by OWNER and ENGINEER. No such departures shall be made without the prior written approval of the OWNER or ENGINEER. Approved changes shall be made without additional cost to the OWNER for this work or related work under other Contracts of the Project.

- B. The specific equipment proposed for use by the CONTRACTOR on the project may require changes in structures, auxiliary equipment, piping, electrical, mechanical, controls or other work to provide a complete satisfactory operating installation. The CONTRACTOR shall submit to the ENGINEER, for approval by OWNER and ENGINEER, all necessary Drawings and details showing such changes to verify conformance with the overall project structural and architectural requirements and overall project operating performance. The Bid Price shall include all costs in connection with the preparation of new Drawings and details and all changes to construction work to accommodate the proposed equipment, including increases in the costs of other Contracts.

1.4 CONSTRUCTION PERMITS, EASEMENTS AND ENCROACHMENTS

- A. The OWNER shall obtain or cause to be obtained all permanent and temporary construction easements required. No easements are anticipated for this project.
- B. The CONTRACTOR shall obtain, keep current and pay all fees for any other necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract limits and which will be occupied, encountered, used, or temporarily interrupted by the CONTRACTOR's operations unless otherwise stated. CONTRACTOR shall pay plan review fees and any other fees for required permits. Record copies of all permits shall be furnished to the ENGINEER and OWNER.
- C. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the CONTRACTOR's responsibility to become familiar with and comply with such regulations or requirements as they apply to CONTRACTOR's operations on this Project.
- D. The CONTRACTOR will be required to follow the requirements established by all permits necessary for the construction of this project. The following is a list of all permits that must be obtained prior to the beginning of construction.
 - 1. Applicable City Building Permits (all trades)
- E. The permits for the various trades shall be applied for, paid for and procured by the CONTRACTOR. A cash allowance of \$5,000 has been included in the Contract price for the payment of the permit fees. The CONTRACTOR must submit a copy of these permits to the ENGINEER prior to construction.

1.5 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the ENGINEER is required to provide additional engineering services as a result of substitution of materials or equipment which are not "or equal" by the CONTRACTOR, or changes by the CONTRACTOR in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the ENGINEER is required to examine and evaluate any changes proposed by the CONTRACTOR for the convenience of the CONTRACTOR, then the ENGINEER's charges in connection with such additional services shall be charged to the CONTRACTOR by the OWNER.

- B. Structural design shown on the Contract Drawings is based upon typical weights for major items of equipment as indicated on the Contract Drawings and specified. If the equipment furnished exceeds the weights of said equipment, the CONTRACTOR shall assume the responsibility for all costs of redesign and for any construction changes required to accommodate the equipment furnished, including the ENGINEER's expenses in connection therewith.
- C. In the event that the ENGINEER is required to provide additional engineering services as a result of CONTRACTOR's errors, omissions, or failure to conform to the requirements of the Contract Documents, or if the ENGINEER is required to examine and evaluate any changes proposed by the CONTRACTOR solely for the convenience of the CONTRACTOR, then the ENGINEER's charges in connection with such additional services shall be charged to the CONTRACTOR by the OWNER.

1.6 ADDITIONAL OWNER'S EXPENSES

- A. In the event the Work of this Contract is not completed within the time set forth in the Contract or within the time to which such completion may have been extended in accordance with the Contract Documents, the additional engineering or inspection charges incurred by the OWNER may be charged to the CONTRACTOR and deducted from the monies due the CONTRACTOR. Extra work or supplemental Contract work added to the original Contract, as well as extenuating circumstances beyond the control of the CONTRACTOR, will be given due consideration by the OWNER before assessing engineering and inspection charges against the CONTRACTOR.
- B. Charges assessed to the CONTRACTOR for additional engineering and inspection costs will be determined based on actual hours charged to the job by the ENGINEER. Daily rates will depend on the number and classifications of employees involved, but in no case shall such charges exceed \$900 per day for field personnel and \$1,100 per day for engineering personnel, based on an eight-hour workday.
- C. Charges for additional OWNER's expenses shall be in addition to any liquidated damages assessed in accordance with the Contract.

1.7 PROTECTION OF WORK

- A. Unless otherwise specifically permitted, all work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work as will not suffer injury to workmanship or materials will be permitted. CONTRACTOR shall carefully protect the work against damage or injury from the weather, and when work is permitted during freezing weather, CONTRACTOR shall provide and maintain approved facilities for heating the materials and for protecting the finished work.

1.8 FIRE PROTECTION – OZONE BUILDING

- A. CONTRACTOR shall take all necessary precautions to prevent fires at or adjacent to the work, buildings, etc., and shall provide adequate facilities for extinguishing fires which do occur. Burning of debris is not permitted on the project site.
- B. When fire, spark or explosion hazards are created near the work because of the work (welding/grinding/soldering) the CONTRACTOR shall immediately alert the local Fire Marshal, the ENGINEER, and the OWNER of such tank or device. The CONTRACTOR shall exercise all safety precautions and shall comply with all instructions issued by the Fire Marshal and shall cooperate with the OWNER to prevent the occurrence of fire or explosion. This facility generates ozone for disinfection purpose and in the right conditions can accelerate, expand or cause unexpected fire hazards.

- C. Hydrants must be maintained in service and approved during all phases of work.
- D. Storage area for construction materials must not interfere with fire/emergency site access.
- E. All material demolished from site should not be stored on location.
- F. The area of work underlined in this section is in and around ozone generator. This equipment produces gas that is highly explosive. The CONTRACTOR shall take necessary precautions to work in the area including as a minimum spark free tools and additional temporary ventilator equipment.

1.09 CHEMICALS

- A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of either the EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable rules and regulations.
- B. Provide MSDS sheets for all chemicals to OWNER.

1.10 FIRST AID FACILITIES AND ACCIDENTS

- A. First Aid Facilities
 - 1. The CONTRACTOR shall provide at the site such equipment and facilities as are necessary to supply first aid to any of CONTRACTOR's personnel who may be injured in connection with the work.
- B. Accidents
 - 1. The CONTRACTOR shall promptly report, in writing, to the ENGINEER and OWNER all accidents whatsoever out of, or in connection with, the performance of the work, whether on or adjacent to the site, which cause death, personal injury or property damage, giving full details and statements of witnesses.
 - 2. If death, serious injuries, or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the OWNER and the ENGINEER.
 - 3. If any claim is made by anyone against the CONTRACTOR or a Subcontractor on account of any accidents, the CONTRACTOR shall promptly report the facts, in writing, to the ENGINEER and OWNER, giving full details of the claim.

1.11 BLASTING AND EXPLOSIVES

- A. The use of blasting or explosives shall not be allowed under this project.

1.12 LIMITS OF WORK AREA

- A. The CONTRACTOR shall confine the construction operations within the Contract limits shown on the Drawings and/or property lines and/or fence lines. Storage of equipment and materials, or erection and use of sheds outside of the Contract limits, if such areas are the property of the OWNER, shall be used only with the OWNER's approval. Such storage or temporary structures, even within the Contract's limits, shall be confined to the

OWNER's property and shall not be placed on properties designated as easements or rights-of-way unless specifically permitted elsewhere in the Contract Documents.

1.13 WEATHER CONDITIONS

- A. No outdoor work shall be done when the weather is unsuitable. The CONTRACTOR shall take necessary precautions (in the event of impending storms) to protect all work, materials, or equipment from damage or deterioration due to floods, driving rain, or wind, and snow storms. The OWNER reserves the right to order that additional protection measures over and beyond those proposed by the CONTRACTOR, be taken to safeguard all components of the Project. The CONTRACTOR shall not claim any compensation for such precautionary measures so ordered, nor claim any compensation from the OWNER for damage to the work from weather elements.
- B. The mixing and placing of concrete or pavement courses, the repairing/laying of masonry, shall be stopped during rainstorms and when ordered by the OWNER; and all freshly placed work shall be protected by canvas or other suitable covering in such manner as to prevent running water from coming in contact with it. Sufficient coverings shall be provided and kept ready at hand for this purpose. The limitations and requirements for mixing and placing concrete, or laying of masonry, in cold weather shall be as described elsewhere in these Specifications.
- C. The ENGINEER shall have permissive authority over the work which is proposed to be done during the winter months. The CONTRACTOR shall provide adequate weather protection, temporary heating and take any other measures which are necessary to ensure that the work performed during the winter months is properly installed and protected against damage from freezing.

1.14 USE OF FACILITIES BEFORE COMPLETION

- A. The OWNER reserves the right to enter and use any portion of the constructed facilities before final completion of the whole work to be done under this Contract. However, only those portions of the facilities which have been completed to the OWNER's satisfaction, as evidenced by issuing a Certificate of Partial Completion covering that part of the work, shall be placed in service.
- B. It shall be the OWNER's responsibility to prevent premature connections to or use of any portion of the installed facilities by private or public parties, persons or groups of persons, before the OWNER issues the Certificate of Partial Completion covering that portion of the work to be placed in service.
- C. Consistent with the approved progress schedule, the CONTRACTOR shall cooperate with the OWNER, his agents, and the ENGINEER to accelerate completion of those facilities, or portions thereof, which have been designated for early use by the OWNER.

1.15 PIPING, VALVES AND SUPPORTS

- A. Various pipelines and conduits are shown on the Plans in diagram form. Where such pipelines and conduits are shown only in diagram, they shall be arranged clear of other pipelines, equipment and walking areas, and be accessible for maintenance. Such pipelines shall be fitted and installed in a neat and workmanlike manner in accordance with approved Shop Drawings. An adequate number of unions shall be provided in main pipe and branch pipe runs to facilitate dismantling or removal of pipeline sections without disturbing adjacent branch or connecting lines. Pipe and conduit supports shall be designed by CONTRACTOR and approved by ENGINEER unless noted otherwise in the Contract Documents.

1.16 DELIVERY, STORAGE, AND HANDLING

- A. All materials, supplies and equipment, whether furnished by the CONTRACTOR or by the OWNER, shall be delivered, stored and handled as to prevent the inclusion of foreign materials and/or damage by water, freezing, breakage or other causes. The ENGINEER may require the CONTRACTOR to provide an enclosed storage shed for the storage of the above-mentioned materials, supplies and equipment. Packaged materials shall be delivered in the original unopened containers and shall be stored until ready for use. All materials which have been stored shall meet the requirements of the Specifications at the time they are used in the project.

PART 2 – PRODUCTS

(NOT USED)

PART 3 – EXECUTION

(NOT USED)

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY

- 1.A. The proposed improvements shall be fully constructed, started, tested and put into operation while the Water Treatment Plant (WTP) remains in service.
- 1.B. The existing plant shall be maintained in continuous operation during the entire construction period of this Project. The intent of this section is to outline the minimum requirements necessary to provide continuous availability of the required capacity throughout the construction period. One of the two (2) chillers shall remain fully functional from April 1 through October 15.
- 1.C. Work under this Contract shall be scheduled and conducted by the CONTRACTOR so as not to impede any plant process, discharge water, or cause odor or other nuisance except as explicitly permitted hereinafter. In performing the work shown and specified, the CONTRACTOR shall plan and schedule his work to meet the OWNER's operating requirements, and the constraints and construction requirements as outlined in this Section. The CONTRACTOR shall pay all civil penalties, costs, assessments, etc., associated with any failure or inability to supply water from the pump stations that do not meet water quality standards, adequate quantity requirements or maintain system pressure requirements; provided the inadequacy was associated with the CONTRACTOR's work.
- 1.D. The CONTRACTOR shall be responsible for coordinating the general construction and electrical, HVAC, plumbing, and instrumentation construction schedules and for ensuring that permanent or temporary power is available for all existing, proposed, and temporary facilities that are required to be on line at any given time.
- 1.E. The CONTRACTOR has the option of providing temporary facilities that can eliminate a constraint, provided it is done without cost to the OWNER and provided that all requirements of these Specifications are fulfilled. Work not specifically covered in the following paragraphs may, in general, be done at any time during the Contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section shall be consecutive calendar days.
- 1.F. The CONTRACTOR is allowed to suggest a construction sequence different from what is listed in the Sample Standard Contract for the OWNER's consideration. The suggested construction sequence is included in the front-end documents (Article III – Time of Completion), and in Table 1 of this specification Section.

1.2 GENERAL CONSTRAINTS

- 2.A. The CONTRACTOR shall schedule the Work so that the plant is maintained in continuous operation. Portions of the plant processes shall be maintained in continuous operation during the construction period except during approved process interruptions. Shutdowns shall conform to the requirements hereinafter specified and shall be minimized by the CONTRACTOR as much as possible. If in the judgment of the ENGINEER, a requested shutdown is not required for the CONTRACTOR to perform the Work, the CONTRACTOR shall utilize approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the OWNER. Shutdowns shall not begin until all required materials are on hand and ready for installation. Each shutdown

period shall commence at a time approved by the OWNER. If the CONTRACTOR completes all required Work before the specified shutdown period has ended, the OWNER may immediately place the existing system back into service.

- 2.B. The CONTRACTOR shall give OWNER advance notice of proposed shutdowns of any pipe, process, equipment, tank, or power source, and shall present all desired shutdowns in the 30 and 60-day schedules at the progress meetings. Shutdowns shall be fully coordinated with the OWNER at least 72 hours before the scheduled shutdown. CONTRACTOR shall lockout/tagout equipment and power sources involved in the shutdowns and diversions. The OWNER's personnel shall operate OWNER's facilities during shutdowns.
- 2.C. The CONTRACTOR shall submit a proposed written plan of work, with a request to schedule shutdown work for OWNER and ENGINEER approval. Work plan shall include sequence of events, needs for coordination with plant staff, plans for lock-out/tag-out, contingency plans for how to return equipment and tanks to service early if needed for emergencies, and details of how the duration of the shut-down shall be minimized.
- 2.D. Short-term shutdowns (24 hours or less) shall require seven (7) days prior notice to schedule date and time with OWNER, unless otherwise noted herein. Once a short-term shutdown starts, CONTRACTOR shall work continuously until the work is complete and the disrupted process or system can be returned to service. Long-term shutdowns (longer than 24 hours) shall require 14 days prior notice to schedule date and time with OWNER, unless otherwise noted herein. The CONTRACTOR shall submit a plan of work showing sequence of events throughout shutdown period, and listing all items requiring coordination with OWNER's staff. The CONTRACTOR shall schedule a coordination meeting with the OWNER prior to the initiation of a long-term shutdown. Once a long-term shutdown starts, CONTRACTOR shall work on the shutdown area full days, every regular work day, until the work is complete, and the disrupted process or system can be returned to service, unless otherwise required herein.
- 2.E. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the CONTRACTOR's work limits to maintain continuous and dependable operation shall be furnished by the CONTRACTOR at the direction of the OWNER or ENGINEER at no extra cost to the OWNER.
- 2.F. The OWNER shall have the authority to order work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the pump station operations. The OWNER reserves the right to cancel a scheduled shutdown, without additional compensation due the CONTRACTOR, and shall consider a Contract extension if the cancellation affects the CONTRACTOR's critical path.
- 2.G. Unless specifically required by this specification, the CONTRACTOR shall not request more than one shutdown occur simultaneously.
- 2.H. If the CONTRACTOR impairs performance or operation of the WTP because of not complying with specified provisions for maintaining WTP operations, then the CONTRACTOR shall immediately make all repairs or replacements and do all work necessary to restore the WTP to operation to the satisfaction of the OWNER and ENGINEER. Such work shall progress continuously to completion 24 hours per day and seven work days per week.

- 2.I. After any damage to the existing facilities by the CONTRACTOR's Work that, in the opinion of the OWNER, constitutes an emergency, the CONTRACTOR shall be immediately available and provide immediate services for the repair of damage and mitigation of the emergency.
- 2.J. Shutdowns shall be scheduled between Monday and Friday, unless there are extenuating circumstances approved by the ENGINEER.

1.3 GENERAL REQUIREMENTS

3.A. Access to Site, Roadways, and Parking Areas

- 3.A.1. An unobstructed traffic route through all gates shall be maintained at all times for the OWNER's operations personnel and maintenance equipment. The CONTRACTOR shall be responsible for providing access to the construction area.
- 3.A.2. An unobstructed traffic route around the site shall be maintained at all times for the OWNER's operations personnel, maintenance equipment, and delivery vehicles. Vehicular access to the buildings for OWNER personnel and for delivery vehicles shall be maintained at all times by the CONTRACTOR except as explicitly permitted hereinafter.
- 3.A.3. The CONTRACTOR shall provide temporary measures to protect the existing pavement by filling over with temporary asphalt or supplying other measures acceptable to the ENGINEER, and he shall repair any damage to existing paved surfaces that occurs during the construction period. Any areas disturbed along the shoulders of the access road and interior roads and elsewhere inside and outside of the plant shall be repaired, graded, seeded, etc. as necessary to match pre-construction conditions.
- 3.A.4. The CONTRACTOR shall not undertake the restoration/construction of roadway (paved, gravel, or asphalt overlay) until all other work has been completed.
- 3.A.5. The CONTRACTOR shall not disturb the maintenance of Ozone Building operations without a written and approved plan.
- 3.A.6. The CONTRACTOR shall submit plans for approval for any needed outages or disturbances to operations. These plans shall include the area, process or systems that shall be impacted and duration of the outage. No plans can be implemented without written authorization from OWNER or ENGINEER.

B. Personnel Access

- 3.B.1. OWNER's personnel shall have access to all areas which remain in operation throughout the construction period. The CONTRACTOR shall locate stored material, dispose of construction debris and trash, provide temporary walkways, provide temporary lighting, and other such work as directed by the ENGINEER to maintain personnel access to areas in operation. Access and adequate parking areas for OWNER's personnel must be maintained throughout construction.

C. Building Heating and Ventilating

3.C.1. Building heating and ventilating for the existing structures shall be in service for the entire construction period. While bringing equipment into the building, the CONTRACTOR shall only open doors as necessary to prevent heat loss.

D. Power, Light and Communications Systems (General)

3.D.1. Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas which remain in operation. Individual units may be disconnected as required for replacement, but service shall be available at all times.

1.4 SPECIFIC OPERATIONAL CONSTRAINTS

4.A. The General CONTRACTOR shall schedule the work for the following based on the constraints given in such a manner as to maintain the pump station operation. CONTRACTOR shall submit a proposed construction schedule including all planned system and shutdowns and tie-ins for the OWNER's and ENGINEER's review no later than 30 calendar days after issuance of the Notice to Proceed. At a minimum, Construction Schedule shall indicate a proposed start date and duration for each of the items listed in this section. No construction shall begin on any of the items listed in this section until the proposed schedule has been approved. Refer to Table 1 for further details on dates and expected durations.

4.B. CONTRACTOR shall install as much of the new equipment that is to replace the existing equipment as feasible prior to shut-down of any pipe, to minimize the duration of the shut-down.

4.C. OWNER shall be responsible to turn all valves necessary to isolate pipe sections for connection, and to place the new pipe section to service.

4.C.1. Chiller Replacement

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

**Table 1
City of Ann Arbor
WTP Chiller Replacement
Spec Section 01140**

Summary of Shutdown Notices, Durations, Dates, Deadlines, and Liquidated Damages

Part	Item	Notice to OWNER (days)	Maximum Duration	Dates and Deadlines	Liquidated Damages (See Note)
1.1	General short-term	7	< 24 hours	NA	\$250/day
	General long-term	14	> 24 hours	Submit schedule/sequence Requires coordination meeting	\$250/day
4.C.1	Chiller Replacement - 40 ton	30	18 weeks	Within January 1, 2018-May 10, 2019	\$1,000/day
4.C.1	Chiller Replacement -100 ton	30	16 weeks	Within October 1, 2019-January 21, 2020	\$1,000/day

Note: Liquidated damages shall apply for each shutdown that exceeds its assigned maximum duration. Liquidated damages shall also apply for each shutdown that is not completed by its assigned deadline or within its assigned dates. Liquidated damages for exceeding durations shall be in addition to damages for missing assigned deadlines or dates.

END OF SECTION

SECTION 01290

PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Schedule of Values
- B. Initial Application of Payment
- C. Application for Payment
- D. Application for Payment at Substantial Completion
- E. Final Payment Application

1.2 RELATED SECTIONS

- A. Section 01330 - Submittal Procedures

1.3 SCHEDULE OF VALUES

- A. Submit typed schedule for review and approval. The approved schedule of values will be used to prepare future Applications for Payment.

As a minimum, the following items shall be submitted as separate line items. Each piece of equipment shall have two line items in the schedule of values; one for equipment and one for installation:

- 1. 40 Ton Chiller
 - 2. 40 Ton Chiller Condenser
 - 3. 100 Ton Chiller
 - 4. Cooling Water Pump #1
 - 5. Cooling Water Pump #2
 - 6. Cooling Water Pump VFD #1
 - 7. Cooling Water Pump VFD #2
- B. Submit Schedule of Values in triplicate to the ENGINEER within 15 days after date of OWNER-CONTRACTOR Agreement for approval.
 - C. Format: Identify each line item with number and title of the major specification Section.
 - D. Include within each line item, a direct proportional amount of CONTRACTOR's overhead and profit.
 - E. Revise schedule to list approved Change Orders, with each Application for Payment.
 - F. Include the following Project Identification on the Schedule of Values:
 - 1. Project Name and Location
 - 2. Name of ENGINEER
 - 3. Project Number

WTP OZONE GENERATION BUILDING CHILLER REPLACEMENT

4. CONTRACTOR's Name and Address
 5. Date of Submittal
- G. Arrange Schedule of Values in a tabular form with separate rows for each Specification Section and separate columns for each major structure of area of Work. Additionally, separate line items for the following shall be included:
1. Mobilization (Maximum 5% of Contract Total)
 2. Bonds & Insurance
 3. Allowances
 4. Start-Up and Commissioning
 5. Training and O&M Manuals (Minimum 1% of Contract Total)
 6. Project Close-Out
- H. Provide a breakdown of the Contract Price in sufficient detail to facilitate continued evaluation of Application for Payment and progress reports. Break principal subcontract amounts down into several line items.
- I. For each part of the Work where an Applicant for Payment may include materials for equipment, purchased or fabricated and stored, but not yet installed, provide separate line items on Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
- J. Update and resubmit schedule of values when change orders result in a change in the contract price.
- K. Schedule of Valves shall be submitted as a shop drawing for OWNER approval.
- L. Schedule of Valves shall be divided into the major divisions.

1.4 INITIAL APPLICATION FOR PAYMENT

- A. Administrative actions and submittals that must precede submittal of the first Application for Payment include the following:
1. List of Subcontractors
 2. List of Principal Suppliers and Fabricators
 3. Schedule of Values
 4. CONTRACTOR's Construction Schedule (preliminary not final)
 5. Submittal Schedule (preliminary if not final)
 6. All City of Ann Arbor Living Wages Ordinance requirements, including but not limited to, weekly payrolls, payroll affidavits, and all related documents.

1.5 APPLICATIONS FOR PAYMENT

- A. Submit six (6) copies of each application.
- B. Content and Format: Utilize Schedule of Values and Change Orders for listing items in Application for Payment.
- C. Payment Period: Payments made according to the schedule described in the General Conditions and or in accordance with the OWNER's requirements.
- D. With each copy of the applications submit Waiver of Lien from all subcontractors or suppliers for work included in Application for Payment, other than the first pay application.
- E. Submit a completed CONTRACTOR's Declaration with each Application for Payment.
- F. All City of Ann Arbor Living Wages Ordinance requirements, including but not limited to, weekly payrolls, payroll affidavits, and all related documents.

1.6 APPLICATION FOR PAYMENT AT SUBSTANTIAL COMPLETION

- A. Following issuance of Certificate of Substantial Completion, submit an Application for Payment.
- B. Administrative actions and submittals that shall proceed or coincide with this application include:
 - 1. Occupancy permits and similar approvals.
 - 2. Warranties (guarantees) and maintenance agreements.
 - 3. Test/adjust/balance records.
 - 4. Maintenance instructions; O&M manuals.
 - 5. Start-up performance reports and inspection reports.
 - 7. Changeover information related to OWNER's occupancy, use, operation and maintenance.
 - 8. Final cleaning.
 - 9. Application for reduction of retainage, and consent of surety.
 - 10. Advice on shifting insurance coverage.
 - 11. List of incomplete work, recognized as exceptions to ENGINEER's Certificate of Substantial Completion.
 - 12. As-Built Drawings.
 - 13. Delivery of spare parts.

1.7 FINAL PAYMENT APPLICATION

- A. Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
1. Completion of Project Closeout requirements.
 2. Completion of items specified for completion after Substantial Completion.
 3. Assurance that unsettled claims will be settled.
 4. Assurance that work not complete and accepted will be completed without undue delay.
 5. Proof that taxes, fees, and similar obligations have been paid.
 6. Removal of temporary facilities and services.
 7. Removal of surplus materials, rubbish, and similar elements.
 8. CONTRACTOR's waivers of liens for project.
 9. Completion of all punch list items and written description of how all punch list items were addressed.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01310

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Project Superintendence
- B. Coordination and Project Conditions
- C. Field Engineering
- D. Pre-Construction Conference
- E. Site Mobilization Meeting
- F. Progress Meetings
- G. Preinstallation Meetings

1.2 PROJECT SUPERINTENDENCE

- A. CONTRACTOR's superintendent shall be on site full time for the duration of the project during construction periods and shall meet the experience requirements identified in the Instructions to Bidders.

1.3 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate construction operations included under different Section of the Specifications that are dependent upon each other for proper installation, connection, and operation. Where installation of one part of the work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair. Make adequate provisions to accommodate items scheduled for later installation.
 - B. CONTRACTOR shall be responsible for coordinating any exchange of safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at Site in accordance with Laws or Regulations. CONTRACTOR shall train CONTRACTOR's employees on use of these sheets and shall keep a master copy on hand at site.
- Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:
- 1. Preparation of Schedules
 - 2. Installation and removal of temporary facilities.

3. Delivery and processing of submittals.
 4. Progress meetings.
 5. Request of information.
 6. Project closeout activities.
- C. Coordinate scheduling, submittals, and Work of the various Sections of the Contract Documents to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- D. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- E. Check motor voltages and control characteristics.
- F. Coordinate controls, interlocks, wiring of switches, and relays.
- G. Coordinate wiring and control diagrams.

1.4 FIELD ENGINEERING

- A. Field verify all dimensions and measurements.
- B. Confirm Drawing dimensions and elevations including manufacturer Shop Drawings.

1.5 PRE-CONSTRUCTION CONFERENCE

- A. OWNER will schedule a pre-construction conference and organizational meeting at the site or other convenient location prior to commencement of construction activities to review responsibilities and personnel assignments.
- B. Attendees: OWNER, ENGINEER and ENGINEER's consultants, CONTRACTOR and its superintendent, major subcontractors, manufacturers, suppliers, utility companies, and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matter relating to the work.
- C. Agenda: Discuss items of significance that could affect progress including such topics as:
 1. Site Access and Badging
 2. Tentative Construction Schedule.
 3. Critical Work sequencing.
 4. Designation of responsible personnel.
 5. Coordination with other construction work and other CONTRACTORS.
 6. Procedures for processing field decisions and Change Orders.
 7. Procedures for processing Applications for Payment.

8. Distribution of Contract Documents.
9. Submittal of Shop Drawings, Product Data, Samples and Schedule.
10. Preparation of record documents
11. Use of the premises.
12. Office, work, and storage areas.
13. Equipment deliveries and priorities.
14. CONTRACTOR's Quality Assurance Plan.
15. Safety procedures.
16. First Aid.
17. Security.
18. Housekeeping.
19. Working hours

1.6 SITE MOBILIZATION MEETING

- A. OWNER will schedule a conference at the project site prior to the CONTRACTOR's occupancy.
- B. Attendance required by the OWNER, ENGINEER, CONTRACTOR's Superintendent, and the major subcontractors.
- C. CONTRACTOR shall submit a site plan identifying the CONTRACTOR's limits of work, trailer and storage area locations, for coordination with other work.
- D. Agenda:
 1. Use of premises by OWNER and CONTRACTOR.
 2. OWNER's requirements.
 3. Construction facilities and controls.
 4. Temporary utilities.
 5. Security and housekeeping procedures.
 6. Schedules.
 7. Procedures for maintaining record documents.
 8. Inspection and acceptance of equipment put into service during the construction period.

1.7 SITE SAFETY MEETING

- A. OWNER will schedule a single conference at the project site prior to the CONTRACTOR's commencement to site activities.
- B. Attendance required by the OWNER, ENGINEER, CONTRACTOR's Superintendent, CONTRACTOR's Safety Officers, and all subcontractors.
- C. Agenda:
 - 1. Safety Procedures
 - 2. First Aid
 - 3. Security

1.8 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record and distribute the minutes.
- C. Attendance Required: Job superintendent, major subcontractors and suppliers, OWNER, ENGINEER as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems that impede planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of RFIs.
 - 7. Review of off-site fabrication and delivery schedules.
 - 8. Maintenance of progress schedule.
 - 9. Corrective measures to regain projected schedules.
 - 10. Planned progress during succeeding work period.

- 11. Coordination of projected progress.
 - 12. Maintenance of quality and work standards.
 - 13. Effect of proposed changes on progress schedule and coordination.
 - 14. Other business relating to Work.
- E. Record minutes and distributes copies within two (2) days after meeting to participants, with copies to ENGINEER, OWNER, participants, and those affected by decisions made.
 - F. Submit updated construction schedule to the OWNER/ENGINEER for review two (2) days before each progress meeting. Revise construction schedule as needed after each progress meeting and resubmit to the OWNER/ENGINEER with the meeting minutes.

1.9 PREINSTALLATION OR SHUTDOWN COORDINATION MEETING

- A. When required in individual specification sections, or as deemed necessary by the CONTRACTOR, ENGINEER or OWNER, convene a preinstallation or shutdown coordination meeting at the site prior to commencing work.
- B. Require attendance of parties directly affecting, or affected by, Work of the specific section.
- C. Notify OWNER/ENGINEER five (5) working days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of shutdown, installation, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distributes copies within two (2) days after meeting to participants, with copies to ENGINEER/OWNER participants, and those affected by decisions made.

1.10 FINAL INSPECTION MEETING

- A. When the CONTRACTOR has provided written notice that the project is complete, a final inspection meeting shall be scheduled with the CONTRACTOR, ENGINEER, and OWNER.
- B. ENGINEER will notify the CONTRACTOR in writing of all items which this inspection reveals are incomplete or defective.
- C. CONTRACTOR shall immediately take all necessary measures to remedy such deficiencies. A written description of how each item has been addressed shall be submitted to the ENGINEER and OWNER.

1.11 CLOSEOUT/WARRANTY MEETING

- A. Prior to final application for payment, a closeout/warranty meeting shall be scheduled with the CONTRACTOR, ENGINEER and OWNER.

B. Agenda:

1. Project record document review.
2. Verify receipt of spare parts and maintenance products.
3. Review preventative maintenance schedule.
4. Review submitted warranties and bonds.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01320

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pre-Construction Documentation
- B. Photographic Progress Documentation

1.2 ELECTRONIC STORAGE

- A. Maintain organized electronic storage of project pre-construction and progress photos and video until Final Payment.

1.3 PRE-CONSTRUCTION DOCUMENTATION

- A. CONTRACTOR shall take a sufficient number of digital pre-construction photographs, minimum 100, so as to resolve any disputes, which may arise regarding the considerations prior to and subsequent to construction.
- B. CONTRACTOR shall furnish one USB flash drive of the digital Pre-construction photographs to the ENGINEER and shall make others available for review in settling any disputes. All photos shall be individually named and organized by the CONTRACTOR.
- C. If a dispute arises where digital pre-construction photographs was not taken, the disputed area shall be restored to the extent directed by the ENGINEER and to the complete satisfaction of the ENGINEER.

1.4 PROGRESS PHOTOGRAPHS

- A. CONTRACTOR shall take enough digital photographs to sufficiently record the construction progress of the project. All critical construction events shall be thoroughly recorded with photographs. All photos shall be individually named and organized by the CONTRACTOR.
- B. With each application for payment, the CONTRACTOR shall submit all photos taken during the previous month on one USB flash drive.
- C. CONTRACTOR shall organize the photos into files by work area, discipline and date.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHS

- A. Digital
- B. Size: 10.0 Megapixel Minimum
- C. Format: JPEG

2.2 IDENTIFICATION

- A. Identify in caption below each print:
 - 1. Description and location of view.
 - 2. Time and date of exposure.
 - 3. Equipment name.
 - 4. Any other applicable information.

PART 3 - EXECUTION

3.1 TECHNIQUE

- A. Factual presentation.
- B. Correct exposure and focus.
 - 1. High resolution and sharp.
 - 2. Maximum depth-of-field.
 - 3. Minimum distortion.

3.2 VIEWS REQUIRED

- A. Consult with ENGINEER for instructions concerning views required.
- B. Photograph from locations to adequately illustrate state of project, or condition of construction.
- C. In addition, provide photographs prior to, at critical stages of, and at the end of construction, when they do not coincide with scheduled times.

3.3 DELIVERY OF PRINTS

- A. Deliver digital copies of photos monthly to accompany each request for progress payment. Photos shall be submitted on one USB flash drive.
- B. Deliver 3-ring photo binder with the final application for payment.

END OF SECTION

SECTION 01330

SUMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Submittal Procedures
- B. Certifications
- C. Shop Drawings
- D. Product Data
- E. Samples
- F. Manufacturers' Instructions
- G. Manufacturers' Field Reports
- H. Construction Schedule
- I. Submittal Schedule

1.2 SUBMITTAL PROCEDURES

- A. Package each submittal appropriately for shipping and handling. This shall include an index either on the transmittal or within the submittal itself. Transmit each submittal from CONTRACTOR to ENGINEER using a transmittal form. Submittals received from sources other than CONTRACTOR will be returned without action. Use separate transmittals for items from different Specification Sections. Number each submittal consecutively. Resubmittals should have the same number as the original, plus a letter designation for each Resubmittal (i.e. 7-A, 7-B, etc.). Each submittal shall be referenced to Specification section (i.e. Electrical would be referenced to 16000).
- B. Indicate on the transmittal relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include CONTRACTOR's certification that information complies with Contract Document requirements. On Resubmittal, all changes shall be clearly identified for ease of review. Resubmittals shall be reviewed for the clearly identified changes only. Any changes not clearly identified will not be reviewed and original submittal shall govern.
- C. Include the following information on the label for processing and recording action taken.
 - 1. Project name.
 - 2. Date.
 - 3. Name and address of ENGINEER.

4. Name and address of CONTRACTOR.
 5. Name and address of subcontractor.
 6. Name and address of supplier.
 7. Name of manufacturer.
 8. Number and title of appropriate Specification Sections.
 9. Drawing number and detail references, as appropriate.
- D. Schedule submittals to expedite the Project and deliver to ENGINEER at business address. Coordinate submission of related items. Coordinate related activities that require sequential activity.
 - E. Submit a schedule of Shop Drawing submittals.
 - F. Review and approve Shop Drawings, project data, and samples before submitting them.
 - G. Verify field measurements, field construction criteria, catalog numbers, and similar data. Indicate on the submission exactly what was verified.
 - H. Any markings done by CONTRACTOR shall be done in a color other than red. Red is reserved for ENGINEER's marking.
 - I. The number of copies to be submitted will be determined at the pre-construction conference. Reproducible may be submitted and will be marked and returned to CONTRACTOR. Blue or black line prints shall be submitted in sufficient quantity for distribution to ENGINEER and OWNER recipients.
 - J. Coordinate each submittal with the requirements of the Contract Documents.
 - K. Provide space for CONTRACTOR and ENGINEER review stamps.
 - L. Apply CONTRACTOR's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
 - M. Submit the number of copies that the CONTRACTOR requires, plus four copies that will be retained by the OWNER and ENGINEER.
 - N. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
 - O. No claim will be allowed for damages or extension of time because of delays in the work resulting from rejection of material or from revision and resubmittal of Shop Drawings, project data, or samples.
 - P. No extension of contract time will be authorized because of failure to transmit submittals to ENGINEER sufficiently in advance of the work to permit processing.

- Q. ENGINEER reserves the right to withhold action on a submittal required coordination with other submittals until related submittals are received.
- R. Do not install materials or equipment which requires submittals until the submittals are returned with ENGINEER's/OWNER's stamp and initials or signature indicating approval. The OWNER shall have final approval authority.
- S. CONTRACTOR's responsibility of errors, omissions, and deviations from requirements of Contract Documents in submittals is not relieved by the ENGINEER's review.
- T. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with requirements.
- U. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- V. Submittals not requested in conformance with this Specification will not be recognized or processed.
- W. Revise and resubmit as required, identify all changes made since the previous submittal.
- X. In the event that more than two re-submittals of any submittal is necessary to achieve conformance to the contract requirements, CONTRACTOR shall be charged for excess engineering. The OWNER shall deduct these charges from the CONTRACTOR's final payment. Charges will be \$125.00/hr. minimum 4 hours, for each additional submittal of an item. A tabulated record of such charges will be provided for the CONTRACTOR's review prior to the processing of the final payment.
- Y. Submit new project data and samples when the initial submittal is returned disapproved.

1.3 CERTIFICATIONS

- A. When specified in individual Specification Sections, submit certification by the manufacturer, installation/application subcontractor, or the CONTRACTOR to ENGINEER, in quantities specified for Product Data.
- B. Indicate that the material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certifications may be recent or previous test results of the material or product but must be acceptable to ENGINEER.

1.4 SHOP DRAWINGS

- A. Shop Drawings: Submit to ENGINEER for review for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Produce copies and distribute in accordance with Paragraph 1.2 - Submittal Procedures.
- B. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the project is not considered Shop Drawings.
- C. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules,

patterns, templates, and similar Drawings. Include the following information:

1. Dimension.
 2. Identification of products and materials included.
 3. Compliance with specified standards.
 4. Notation of coordination requirements.
 5. Notation of dimensions established by field measurements.
- D. Nameplate data for equipment including electric motors shall be included on Shop Drawings. Electric motor data shall state the manufacturer, horsepower, service factor, voltage, enclosure type, oversize wiring box, etc.
- E. Shop Drawings shall indicate shop painting requirements to include type of paint and manufacturer.
- F. Standard manufactured items in the form of catalog work sheets showing illustrated cuts of the items to be furnished, scale details, sizes, dimensions, quantity, and all other pertinent information should be submitted and approved in a similar manner.
- G. Measurements given on Shop Drawings or standard catalog sheets, as established from Contract Drawings and as approved by ENGINEER, shall be followed. When it is necessary to verify field measurements, they shall be checked and established by CONTRACTOR. The field measurements so established shall be followed by CONTRACTOR and by all affected trades.
- H. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

1.5 PRODUCT DATA

- A. Product Data: Submit to ENGINEER for review for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Produce copies and distribute in accordance with Paragraph 1.2 - Submittal Procedures.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- C. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

1.6 SAMPLES

- A. Submit full-size, fully fabricated samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial Sections of manufactured or fabricated components, cuts or containers or materials, color range sets, and swatches showing color, texture, and pattern.

- B. Mount, display, or package samples in the manner specified to facilitate review of qualities indicated. Prepare samples to match ENGINEER's sample. Include the following:
 - 1. Generic description of the sample.
 - 2. Sample source.
 - 3. Product name or name of manufacturer.
 - 4. Compliance with recognized standards.
 - 5. Availability and delivery time.
- C. Submit samples for review of kind, color, pattern, and texture, for a final check of these characteristics with other elements, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
- D. Refer to other Specifications Sections for requirements for samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
- E. Preliminary Submittals: Where samples are for selection of color, pattern, texture, or similar characteristics from a range of standard choices, submit a full set of choices for the material or product.
 - 1. Preliminary Submittals will be reviewed and returned with ENGINEER's mark indicating selection and other action.
- F. Except for samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit 3 sets; one will be returned marked with the action taken.
- G. Maintain sets of samples, as returned, at the site, for quality comparisons throughout the course of construction.
- H. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
- I. Sample sets may be used to obtain final acceptance of the construction associated with each set.

1.7 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual Specification Sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to ENGINEER for delivery to OWNER in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.8 MANUFACTURER'S FIELD REPORTS

- A. Submit report in duplicate, within seven (7) days of observation, to ENGINEER and OWNER for Information.
- B. Submit for information for the limited purpose of assessing conformance with information

given and the design concept expressed in the Contract Documents.

1.9 CONSTRUCTION SCHEDULE

A. Bar Chart Schedule:

1. Prepare a fully developed, horizontal bar chart type construction schedule. Schedule shall be prepared electronically in Microsoft Project with critical path and links shown. Submit color copies of the schedule within 30 days of the date established for commencement of the work.
2. Provide a separate item bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the work as indicated on schedule of values.
3. Prepare schedule of sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for entire construction period.
4. Secure time commitments for performing critical elements of the work from parties involved. Coordinate each element on schedule with other construction activities; include minor elements involved in the sequence of the work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the work.
5. Coordinate construction schedule with schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other schedules.
6. Indicate completion in advance of the date established for substantial completion. Indicate substantial completion of schedule to allow time for ENGINEER's procedures necessary for certification of substantial completion

B. Schedule Updating: Provide an updated construction schedule at each progress meeting. Color copies of the updated schedule shall be prepared for all attendees.

1.10 SUBMITTAL SCHEDULE

- A. After development and acceptance of the construction schedule, prepare a complete schedule of submittals. Submit schedule within ten (10) days of the date required for establishment of construction schedule.
- B. Coordinate submittal schedule with the list of subcontracts, schedule of values, and the list of products as well as construction schedule.
- C. Prepare schedule in chronological order; include submittals required during the first 90 days. Provide the following information:
 1. Scheduled date for the first submittal.
 2. Related section number.
 3. Submittal category.
 4. Name of subcontractor.
 5. Description of the part of the work covered.

6. Scheduled date for Resubmittal.
 7. Scheduled date ENGINEER's final release or approval.
- D. The submittal schedule shall reflect critical path Shop Drawings that must be expedited.
 - E. Following response to initial submittal, print and distribute copies to ENGINEER, OWNER, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the project meeting room and field office.
 - F. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the work and are no longer involved in construction activities.
 - G. Schedule Updating: Provide an updated submittal schedule at each progress meeting.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, ENGINEER will review each submittal, mark to indicate action taken, and return promptly.
 1. Compliance with specified characteristics is CONTRACTOR's responsibility.
- B. Action Stamp: ENGINEER will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
 1. Final Unrestricted Release: Where submittals are marked "No Exceptions Taken" that part of the work covered by the submittal may proceed provided it complies with the requirements of the Contract Documents; final acceptance will depend upon the compliance.
 2. Final-But-Restricted Release: When submittals are marked "Make Corrections Noted" that part of the work covered by the submittal may proceed, provided it complies with notation or correction on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
 3. Returned for Resubmittal: When submittal is marked "Rejected" or "Revise and Resubmit" do not proceed with the part of the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.

- a. Do not permit submittals marked “Rejected” or “Revise and Resubmit” to be used at site, or elsewhere where work is in progress.
4. Additional Information Needed: When submittal is marked “Submit Specified Item” CONTRACTOR shall submit requested information.
5. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked “Acknowledge Receipt”.
6. The approval of ENGINEER shall not relieve CONTRACTOR of responsibility for errors on Drawings or submittals as ENGINEER’s checking is intended to cover compliance with Drawings and Specifications and not enter into every detail of the shop work.

END OF SECTION

SECTION 01420

REFERENCES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Reference Standards
- B. Abbreviations and Acronyms

1.02 REFERENCE STANDARDS

- A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.
- B. For products or workmanship specified by association, trade, or Federal Standards; comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
 - 1. Applicable Codes – Latest adopted editions of:
 - a. Michigan Building Code / International Building Code.
 - b. The National Electrical Code, NFPA 70, with amendments.
 - c. International Fire Code.
 - d. International Code Council (ICC) ANSI A117.
 - e. Michigan Mechanical and Plumbing Codes.
- C. Conform to reference standard by date of issue current on date of Contract Documents.
- D. Should specified reference standards conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- E. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.03 ABBREVIATIONS AND ACRONYMS

- A. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change and are believed to be, but are not assured to be, accurate and up to date as of date of Contract Documents.

AA Aluminum Association
 818 Connecticut Avenue, N.W.
 Washington, DC 20006

AABC	Associated Air Balance Council 1518 K St. NW, Suite 503 Washington DC, 20005
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol St, NW, Suite 249 Washington, DC 20001
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
AGC	Associated General Contractors of America 1957 E. Street, N.W. Washington, DC 20006
AISC	American Institute of Steel Construction 400 North Michigan Avenue Eighth Floor Chicago, IL 60611
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, DC 20036
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWS	American Welding Society 550 LeJeune Road, N.W. Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BIA	Brick Institute of America 11490 Commerce Park Drive Reston, VA 22091

CFR	Code of Federal Regulations Office of the Federal Register National Archives and Records Administration Washington, DC 20408
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Road Schaumburg, IL 60195
DHI	Door and Hardware Institute 7711 Old Springhouse Road McLean, VA 22102
EJCDC	Engineers' Joint Contract Documents Committee American Consulting Engineers Council 1015 15th Street, N.W. Washington, DC 20005
FM	Factory Mutual System 1151 Boston-Providence Turnpike P.O. Box 688 Norwood, MA 02062
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
ICBO	International Conference of Building Officials 5360 S. Workman Mill Road Whittier, CA 90601
IEEE	Institute of Electrical and Electronics Engineers 345 East 47th Street New York, NY 10017
IMIAC	International Masonry Industry All-Weather Council International Masonry Institute 815 15th Street, N.W. Washington, DC 20005
ISA	The Instrumentation, Systems, and Automation Society 67 Alexander Drive P.O. Box 12277 Research Triangle Park North Carolina 27709
MBMA	Metal Building Manufacturers Association 1300 Summer Avenue Cleveland, OH 44115-2851

NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NCMA	National Concrete Masonry Association P.O. Box 781 Herndon, VA 22070
NEMA	National Electrical Manufacturers' Association 2101 'L' Street, N.W. Washington, DC 20037
NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
PCI	Prestressed Concrete Institute 201 North Wells Street Chicago, IL 60606
PS	Product Standard U. S. Department of Commerce Washington, DC 20203
SDI	Steel Deck Institute P.O. Box 9506 Canton, OH 44711
SDI	Steel Door Institute 712 Lakewood Center North 14600 Detroit Avenue Cleveland, OH 44107
SSPC	Steel Structures Painting Council 4400 Fifth Avenue Pittsburgh, PA 15213
UL	Underwriters' Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

- B. Government Agencies: Names and titles of state and Federal government standard or specification producing agencies are frequently abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard or specification producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to date as of the date of the Contract Documents.

CE	Corps of Engineers (US Department of the Army) Chief of Engineers - Referral Washington, DC 20314
CFR	Code of Federal Regulations (Available from the Government Printing Office) N. Capitol Street between G and H St. NW
DOT	Department of Transportation 400 Seventh Street, SW Washington, DC 20590
EDA	Economic Development Administration US Department of Commerce 121 N Canal Street, Suite 855 Chicago, IL 60606
EPA	Environmental Protection Agency 401 M Street, SW Washington, DC 20460
MDEQ	Michigan Department of Environmental Quality
MDOT	Michigan Department of Transportation
MIOSHA	State of Michigan OSHA
OSHA	Occupational Safety and Health Administration (US Department of Labor) Government Printing Office Washington, DC 20402

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Quality Control and Control of Installation
- B. References
- C. Testing and Inspection Services
- D. Manufacturers' Field Services

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step-in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. All materials and equipment shall be new, unless otherwise noted.

1.3 REFERENCES

- A. Conform to reference standard by date of issue current on date of Contract Documents.
- B. Should specified reference standards conflict with Contract Documents, request clarification from the ENGINEER before proceeding.
- C. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the ENGINEER shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.4 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Product Requirements
- B. Product Options
- C. Product Substitution Procedures
- D. Product Delivery Requirements
- E. Product Storage and Handling Requirements

1.2 BASIC PRODUCT REQUIREMENTS

- A. Provide products of qualified manufacturers suitable for intended use. Provide products of each type by a single manufacturer unless specified otherwise.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- C. Provide interchangeable components of the same manufacturer for similar components.

1.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

1.4 PRODUCT SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify requirements for submitting requests for Substitutions during the bidding period. This section specifies procedures and requirements affecting substitutions proposed by the CONTRACTOR after the Contract Date.
- B. Where the term "substitutions" is used in this section, it means materials, equipment, or methods of construction which differ from the requirements in the Contract Documents. The term "substitutions" does not include:
 - 1. Requirements provided by Addenda issued prior to the Contract Date.
 - 2. Changes made at the direction of ENGINEER.

3. Changes ordered by governing authorities.
 4. Options described in the Contract Documents.
- C. Substitutions will be considered in the event that:
1. They are related to "or equal" or "or approved equal" provisions in the Contract Documents.
 2. The specified requirements cannot be provided within the Contract Time due to causes beyond the CONTRACTOR's control.
 3. The OWNER will gain a substantial advantage if substitutions are approved.
 4. Substitutions will be considered when a product becomes unavailable through no fault of the CONTRACTOR.
- D. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- E. A request constitutes a representation that the CONTRACTOR:
1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 2. Will provide the same warranty for the Substitution as for the specified product.
 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to OWNER.
 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 5. Will reimburse OWNER and/or ENGINEER for review or redesign services associated with re-approval by authorities.
 6. Will reimburse the OWNER and/or ENGINEER for any costs incurred in the evaluation of any "or equal" or substitution proposal. Such costs shall include, but are not limited to, related charges of the ENGINEER made necessary by the evaluation and acceptance or rejection, as the case may be, of the proposed "or equal" or substitute material or equipment.
- F. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- G. Substitution Submittal Procedure:
1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
 2. Submit Shop Drawings, Product Data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.

3. Submit itemized comparison between the specified product and the substitution product demonstration equivalent.
 4. The ENGINEER will notify CONTRACTOR, in writing, of decision to accept or reject request.
 5. Such submittals do not relieve the CONTRACTOR of obligation to later furnish Shop Drawings, product data, samples, and other submittals required by the Contract Documents.
- H. If any “or equal” or substitute material or equipment differs materially from the material or equipment named or specified, and that difference was not expressly identified in the CONTRACTOR’s request, or results in changes in the work, the ENGINEER has authority to require removal and replacement of that “or equal” or substitute material or equipment. The CONTRACTOR shall bear the delay and costs resulting from (a) any such removal and replacement of “or equal” or substitute materials or equipment; (b) making “or equal” or substitute materials or equipment conform to the requirements of the Contract Documents; and (c) any changes in the work and/or in other work required to accommodate the “or equal” or substitute material or equipment, or both.

1.5 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.6 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide off-site storage and protection when site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation and degradation of Products.
- G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained under acceptable condition.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01730

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes, but is not limited to, all demolition and removals of existing materials, equipment necessary to complete the work specified and as shown on the Contract Drawings. Items for removal include process piping, valves, concrete, chillers, condenser, metals, masonry, electrical equipment, mechanical equipment and all related items.

1.2 SECTION INCLUDES

- A. Selective removal and off-site disposal of following:
 - 1. Removal of all items marked "remove" or "demolish" on Drawings.
 - 2. Removal and protection of existing fixtures and equipment items identified for salvage by the OWNER.

1.3 RELATED SECTIONS

- A. None

1.4 DEFINITIONS

- A. Remove: Remove and dispose of items shown or scheduled. Discard demolished or removed items except for those shown to remain, those shown as reinstalled, those shown as salvaged, and historical items that are to remain OWNER's property.
- B. Remove and Salvage: The OWNER may elect to retain some equipment. Carefully remove and clean salvage items, pack or crate to protect against damage. Transport to a location identified by the OWNER.
- C. Remove and Reinstall: Remove items shown; clean, service and otherwise prepare them for reuse; store and protect against damage. Reinstall items in same location or in location shown.
- D. Existing to Remain: Protect construction or items shown to remain against damage during selective demolition operations. When permitted by ENGINEER, CONTRACTOR may elect to remove items to suitable, protected storage location during selective demolition and properly clean and reinstall items in their original locations.

1.5 SUBMITTALS

- A. Submit schedules listed below to ENGINEER and OWNER.
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
 - 2. Inventory list of removed and salvaged items.

3. Inventory list of OWNER-removed items.
 4. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of OWNER's on-site operations.
 5. Coordination of OWNER's continuing occupancy of portions of existing building and of OWNER's partial occupancy of completed work.
- B. Inventory list of existing equipment to be removed and not reused in Work. OWNER to determine or select items or retention by OWNER

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Demolition operations shall comply with OSHA and EPA requirements and EPA notification regulations insofar as they apply to demolition Work under this Contract.
 2. Comply with hauling and disposal regulations of authorities having jurisdiction.
 3. If hazardous materials are found during demolition operations, comply with all applicable local, state and national requirements for removal and disposal.
- B. Facility Access:
1. Do not close, block or obstruct streets, walks or other occupied or used facilities without written permission from authorities having jurisdiction.
 - a. Use alternative routes around closed or obstructed routes if required by governing regulations.
 2. Coordinate with OWNER's continuing occupation of portions of existing building.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Disassemble or cut large equipment items into smaller pieces to promote safe removal and transportation
1. Transport and unload items requested by OWNER to a designated location at the project site.
 2. Haul away and dispose of debris and materials neither retained by OWNER, nor reused or reinstalled.
 3. Arrange for disposal areas.
 4. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
- B. Unloading Salvage Items: Where shown on Drawings as "Remove and Salvage," carefully remove shown items, clean, store and turn over to OWNER and obtain receipt. OWNER will designate site for receiving items.

- C. Handling: CONTRACTOR shall take every precaution to prevent spillage of materials being hauled in public streets.
 - 1. It shall be CONTRACTOR's responsibility to immediately clean spillage that may accidentally occur.
 - 2. Do not burn removed material on or within Project Site.

1.8 PROJECT CONDITIONS

- A. Materials Ownership:
 - 1. Salvage Materials: Demolished materials shall become CONTRACTOR's property, except for items or materials shown as reused, salvaged, reinstalled, or otherwise shown to remain OWNER's property. Remove demolished material promptly from Site with further disposition at CONTRACTOR's option.
 - 2. Historical artifacts, relics, and similar objects, including but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other articles of historical significance remain property of OWNER. Notify OWNER's Representative when these items are found and obtain method of removal and salvage from OWNER.
 - 3. Transport items of salvageable value to CONTRACTOR to CONTRACTOR's area as they are removed.
- B. Environmental Requirements: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practicable level. Comply with governing regulations relating to environmental protection. Do not use water when it may create hazardous or objectionable conditions including ice, flooding, and pollution.
 - 1. Existing drains shall be protected from debris. Protect drains prior to beginning any demolition work.
- C. Existing Conditions: OWNER will be continuously occupying building areas immediately adjacent to selective demolition areas.
- D. OWNER assumes no responsibility for actual condition of items or structures scheduled for demolition.
- E. OWNER will maintain conditions existing at Contract commencement insofar as practical. However, variations within structure may occur by OWNER's removal and salvage operation before selective demolition work begins.

1.9 SEQUENCING

- A. Conduct selective demolition work in manner that minimizes need for disruption or interference of OWNER's normal on-site operations.
- B. Coordinate with OWNER's continuing occupation of portions of existing building and with sequencing and startup of the new equipment.
- C. Include coordination for shutoff, capping, and continuation of utility services, together with details for dust and noise control protection to ensure uninterrupted on-site operations by OWNER.

1.10 SCHEDULING

- A. Schedule: Submit schedule showing proposed methods and sequence of operations for selective demolition work to OWNER's representative for review before commencement of Work.
- B. Arrange selective demolition schedule so as not to interfere with OWNER's on-site operations.
- C. Give minimum of 15 days advance notice to OWNER of demolition activities, which affect OWNER's normal operations.
- D. Give minimum of 15 days advance notice to OWNER if shutdown of service is necessary during changeover.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Before beginning selective demolition work inspect areas of Work. Survey existing conditions and correlate with requirements shown to determine extent of selective demolition required. Photograph existing structure surfaces, equipment, or surrounding properties, which could be misconstrued as damage resulting from selective demolition work. File with OWNER's representative before starting Work.
- B. Inventory and record condition of items scheduled as "remove and reinstall or items scheduled as "remove and salvage."
- C. Verify disconnection and capping of utilities within the affected area of Work.
- D. If unanticipated mechanical, electrical, or structural elements conflict with intended function or design, investigate, and measure nature and extent of conflicts. Promptly submit detailed written reports to OWNER's Representative. Pending receipt of directive from OWNER's Representative, rearrange selective demolition schedule to continue general job progress without delay.

3.2 PREPARATION

- A. Drain, purge, or remove, collect and dispose of chemicals, gases, explosives, acids, flammable, or other dangerous material before proceeding with selective demolition operations.
- B. Cover and protect furniture, equipment, and permanent fixtures from soiling or damage while demolition Work is done in rooms or areas where items remain in place.
- C. Protect existing finish work that remains in place and becomes exposed during demolition operations.
- D. Protect floors with suitable coverings when necessary.

- E. Where selective demolition occurs immediately adjacent to occupied portions of building, or to separate areas of noisy or extensive dirt or dust operations, construct and maintain temporary, insulated, fire-rated solid dustproof partitions.
 - 1. Construct dustproof partitions of minimum 4-inch studs, 5/8-inch-thick drywall (joints taped on occupied side), 1/2-inch fire-retardant plywood on demolition side, and fill partition cavity with sound-deadening insulation.
 - 2. Equip partitions with dustproof doors and security locks if required.
- F. Provide weatherproof closures for exterior openings resulting from demolition Work. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces, and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
- G. Provide and ensure free and safe passage of OWNER's personnel and general public to and from occupied portions of building around selective demolition areas.
 - 1. Provide temporary barricades and other forms of protection to protect OWNER's personnel and general public from injury.
 - 2. Build temporary covered passageways required by authorities having jurisdiction.
- H. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of demolished structures or elements, or adjacent facilities or Work to remain.
- I. Cease operations and notify OWNER's Representative immediately if safety of structure seems endangered. Take precautions to support structure until determination is made for continuing operations.
- J. Remove protection at completion of Work.

3.3 DEMOLITION

- A. Special Techniques: Demolish concrete and masonry in small Sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- B. For interior slabs on grade, use power saw or removal methods that do not crack or structurally disturb adjacent slabs or partitions.
- C. Completely fill below-grade areas and voids resulting from demolition work.
- D. Explosives: Use of explosives is not allowed.
- E. Interface with Other Work: Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors, or framing.
- F. Site Tolerances: Provide services for effective air and water pollution controls required by local authorities having jurisdiction.

3.5 REPAIR/RESTORATION

- A. Repair damages caused by demolition more extensive than required.
- B. Return structures and surfaces to condition existing before commencing selective demolition Work.
- C. Repair adjacent construction or surfaces soiled or damaged by selective demolition Work.
- D. Promptly repair damages caused to adjacent facilities by demolition Work at no cost to OWNER.

3.6 CLEANING

- A. CONTRACTOR shall maintain an order of neatness and good housekeeping comparable to that observed by OWNER.
- B. Keep tools, scaffolding, and other demolition equipment in neat and orderly arrangement.
- C. Remove dirt and debris resulting from CONTRACTOR's demolition operations from site daily. Dirt and debris shall not collect or interfere with OWNER's facility operations.
- D. Upon completion of demolition Work, remove tools, equipment, and demolished materials from site. Remove protection and leave interior areas broom clean.

END OF SECTION

SECTION 01740

CLEANING AND WASTE MANAGEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Progress Cleaning
- B. Final Cleaning

1.2 GENERAL

- A. Execute cleaning, during progress of the Work, and at completion of the Work.
- B. Adequate periodic cleaning will be a condition for recommendation of progress payments.
- C. Waste Disposal
 - 1. Properly dispose all waste materials, surplus materials, debris, and rubbish off the project site.
 - 2. Provide suitable containers for storage of waste materials and debris.
 - 3. Do not burn or bury rubbish and waste materials on the project site.
 - 4. Do not dispose of volatile or hazardous wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
 - 5. Do not discharge wastes into streams or waterways.
 - 6. Comply with all federal, state, and local anti-pollution laws, ordinances, codes, and regulations when disposing waste materials, debris, and rubbish.

1.3 PROGRESS CLEANING

- A. CONTRACTOR shall periodically clean the Work site at least once weekly.
- B. Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the work.
- C. Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended.
- D. Remove debris from concealed spaces before enclosing the space.
- E. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials.
- F. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration.

- G. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- H. Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces and will not contaminate building systems or electrical or control panels.

1.4 FINAL CLEANING

- A. Complete the following cleaning and waste-removal operations before requesting inspection for Certification of Substantial Completion for the entire project or for a portion of the project:
 - 1. Clean and remove from the project rubbish, waste material, debris, and other foreign substances.
 - 2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - 3. Hose clean sidewalks and loading areas.
 - 8. Clean, wax and polish wood, vinyl, and painted floors.
 - 9. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, and similar spaces.
 - 10. Sweep concrete floors broom clean in unoccupied spaces.
 - 11. Remove tags and labels that are not permanent.
 - 12. Touch up and otherwise repair and restore chipped, scratched, dented, or otherwise marred surfaces to specified finish and match adjacent surfaces. 1) Do not paint over "UL" or similar labels, including mechanical and electrical nameplates.
 - 13. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - 17. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
- B. Maintain the cleaning until OWNER accepts the project or portion thereof.
- C. Leave project clean and in a neat and orderly condition satisfactory to ENGINEER.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
- B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.
- C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Substantial Completion
- B. Final Inspection
- C. Request for Final Payment

1.2 SUBSTANTIAL COMPLETION

- A. Substantial Completion shall be the date as certified by the ENGINEER when the construction of the project, or a specified part thereof, is sufficiently completed, in accordance with the Contract Documents, so that the project, or specified part, can be fully utilized for the purposes for which it was intended.
- B. Substantial Completion of the project will not be granted until successful completion of the operational demonstration as detailed in Section 01810, Start-Up and Commissioning.
- C. Certificates of Substantial Completion will be granted separately for the two (2) chillers.
- D. Before requesting inspection for Certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the work claimed as substantially complete. Include supporting documents for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the contract price.
 - 2. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the work is not complete.
 - 3. Advise OWNER of pending insurance changeover requirements.
 - 4. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
 - 5. Obtain and submit releases enabling OWNER unrestricted use of the work and access to services and utilities; include occupancy permits, operating certificate, and similar releases.
 - 6. Complete final cleanup requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
 - 7. Provide all required demonstration and training sessions.

- E. Substantial completion shall also include the following:
1. Delivery of spare parts.
 2. Complete and approved O&M Manuals.
 3. Completed training sessions.
 4. Cleaning.
 5. Schedule to correct the remaining punch list items.
- F. Inspection Procedures: On receipt of a request for inspection, ENGINEER will either proceed with inspection or advise CONTRACTOR of unfilled requirements.
1. ENGINEER will prepare the Certificate of Substantial Completion following inspection or advise CONTRACTOR of construction that must be completed or corrected before the certificate will be issued.
 2. ENGINEER will repeat inspection when requested and assured that the work has been substantially completed.
 3. Results of completed inspection for the basis of requirements for final acceptance.
 4. Date of Substantial Completion will begin the warranty period unless noted otherwise.

1.3 FINAL ACCEPTANCE

- A. Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 2. Submit an updated final statement, accounting for final additional changes to the contract price.
 3. Submit a copy of ENGINEER's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance. The list shall be endorsed and dated by the ENGINEER.
 4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion, or when OWNER took possession of and responsibility for corresponding elements of the work.
 5. Submit consent of surety to final payment.
 6. Submit a final liquidated damages settlement statement, if applicable.
 7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

8. Submit record drawings, maintenance manuals, damage or settlement survey, property survey, and similar final record information.
 9. Deliver tools, spare parts, extra stock, and similar items.
 10. Complete commissioning and training of OWNER's personnel.
 11. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
 12. Complete final cleaning in accordance with Section 01740, Cleaning and Waste Management.
- B. Reinspection Procedure: ENGINEER will inspect the work upon receipt of notice that work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to the ENGINEER.
1. Upon completion of reinspection, ENGINEER will prepare a certificate of final acceptance, or advise CONTRACTOR of work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, reinspection will be repeated.

1.4 REQUEST FOR FINAL PAYMENT

- A. Submit request for final payment in accordance with the Agreement and General Conditions, as may be modified by the Supplementary Conditions, using procedure specified in Section 01290, Payment Procedures.
- B. Request for final payment shall include:
1. Documents required for progress payments in Section 01290, Payment Procedures.
 2. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.
 3. Releases or Waivers of Lien Rights:
 - a. When submitting releases or Waivers of Lien rights, provide release or Waiver by CONTRACTOR and each Subcontractor and Supplier that provided CONTRACTOR with labor, material, or equipment.
 - b. Provide list of Subcontractors and Suppliers for which release, or Waivers of Lien is required.
 - c. Each release or Waivers of Lien shall be signed by an authorized representative of entity submitting release or waiver to CONTRACTOR and shall include Subcontractor's or Supplier's corporate seal if applicable.

- d. Release or Waivers of Lien may be conditional upon receipt of final payment.
4. Consent of Surety.
5. Documentation that all punch list items are complete.
6. Warranties.
7. Final Operation and Maintenance Manuals.
8. Record Drawings being maintained by the CONTRACTOR.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01780

CLOSEOUT SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Project Record Documents
- B. Spare Parts and Maintenance Products
- C. Preventative Maintenance Instructions
- D. Warranties and Bonds

1.2 PROJECT RECORD DOCUMENTS

- A. Maintain on site one clean, undamaged set of the following record documents; record actual revisions to the work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by OWNER.
- C. Store record documents separate from documents used for construction.
- D. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured horizontal and vertical locations of all concealed and exposed electrical conduits. Conduits shall be shown in plain view on the record drawings with their size and contents indicated.

2. Measured horizontal and vertical locations of all mechanical equipment including valves, pumps, chillers and condensers. Equipment shall be shown in plain view on the Record Drawings with their size and contents indicated.
 3. Field changes of dimension and detail.
 4. Details not on original Contract Drawings.
- F. Indicate the date of revisions to the plans in the appropriate box on the plans.
- G. Submit documents to ENGINEER with claim for final Application for Payment.

1.3 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Provide spare parts, maintenance, and extra products in quantities specified in individual Specification Sections. All wearable items should be supplied to provide at least two (2) years of operation and maintenance.
- B. Deliver to project site and place in location as directed; obtain sign receipt from the City prior to final payment.
- C. Cover and protect parts from moisture.
- D. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers: wooded, cardboard, or palletized.
- E. Stencil on containers:
1. Manufacturer/supplier name.
 2. Unit name.
 3. Spare part name.
 4. Manufacturer catalogue number.
 5. Other identifying information.
 6. Precautionary information.

1.4 PREVENTATIVE MAINTENANCE SCHEDULE

- A. Submit as a separately bound document, in addition to the operation and maintenance data, an equipment maintenance schedule for each piece of equipment. Provide four (4) printed copies and two (2) electronic (.pdf) copies. Each piece of equipment shall be individually tabbed. Include the following:
1. Identity of Equipment.
 2. Routine manufacturer recommended preventative maintenance:
 - a. Daily
 - b. Weekly
 - c. Monthly

- d. Quarterly
 - e. Semi-Annually
 - f. Annually
- B. Equipment maintenance schedule in standard manufacturer format for all equipment.

1.5 WARRANTIES AND BONDS

- A. CONTRACTOR is responsible for maintaining and protecting equipment until final acceptance.
- B. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers. All warranties shall begin at the Date of Substantial Completion, or at the date of acceptance by the OWNER, whichever is later.
- 1. There shall be two (2) Dates of Substantial Completion for the project; one for each chiller.
- C. Execute and assemble all transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers into one binder.
- D. Submit as a separately bound document.
- E. Verify that documents are in proper form, contain full information, and are notarized. Manufacturer's warranties shall be in the name of the OWNER.
- F. Provide Table of Contents and assemble in three-ring binders with durable plastic cover.
- G. Submit prior to Final Application for Payment.
- H. Time of submittals:
- 1. Make warranty submittal within ten days after Date of Substantial Completion, prior to final Application for Payment.
 - 2. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten (10) days after acceptance, listing the date of acceptance as the beginning of the warranty or bond period.
- I. Rejection of Warranties: OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- J. Submit warranties per Table 01780-A, Required Warranties. Where warranty requirements in the specified section or general conditions supersede the requirements of this table, the warranty requirements in the specified section or general conditions shall apply.

Table 01780-A, Required Warranties

Equipment	Specification Section
Chiller	15511, 15513
Piping	15102
Condenser	15512
Controls	15950, 15951

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01781

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Operation and Maintenance Data/Manuals

1.2 SUBMITTALS

- A. Submit operations and maintenance data for all equipment.
- B. Quantity Required and Timing of Submittals:
 - 1. Preliminary Submittal:
 - a. Printed Copies: four (4) copies, exclusive of copies required by CONTRACTOR.
 - b. Electronic Copies: one (1) copy.
 - c. Submit to ENGINEER by the earlier of: ninety (90) days following approval of Shop Drawings and product data submittals, or thirty (30) days prior to starting training of operations and maintenance personnel, or ten days prior to field quality control testing at the Site.
 - d. Furnish preliminary operation and maintenance data submittal in acceptable form and content, as determined by ENGINEER, before associated materials and equipment will be eligible for payment.
 - 2. Final Submittal: Provide final submittal prior to Substantial Completion, unless submittal is specified as required prior to an interim Milestone.
 - a. Printed Copies: four (4) copies.
 - b. Electronic Copies (Searchable PDF): two (2) copies.

1.3 OPERATION AND MAINTENANCE DATA/MANUALS

- A. Binding and Cover:
 - 1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be minimum one-inch wide and maximum of three-inch wide. Binders for each copy of each volume shall be identical.
 - 2. Binders shall be locking three-ring/"D"-ring type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front of each volume.

3. Do not overfill binders.
 4. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.
 5. Provide the following information on cover of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - d. Name of project and, if applicable, Contract name and number.
 - e. Name of building or structure, as applicable.
 6. Provide the following information on spine of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - d. Project name and building or structure name.
 7. The manuals' cover sheets and spines shall all be matching. The CONTRACTOR shall prepare a template for use by the various subcontractors.
- B. Pages:
1. Print pages in manual on 30-pound (minimum) paper, 8.5 inches by 11 inches in size.
 2. Provide each page with binding margin at least one-inch wide. Punch each page with holes suitable for the associated binding.
- C. Drawings:
1. Bind into the manual Drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing specified for pages.
 2. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and Drawing numbers. Include no more than three (3) Drawing sheets per pocket.

D. Copy Quality and Document Clarity:

1. Contents shall be original-quality copies. Documents in the manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals that contain copies that are unclear, not completely legible, off-center, skewed, or where text or Drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or Drawing are unacceptable. Faxed copies are unacceptable.
2. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content. Using highlighters to so indicate options furnished is unacceptable.

E. Organization:

1. Table of Contents:
 - a. Provide table of contents in each volume of each operations and maintenance manual.
 - b. Provide a master table of contents covering the complete set of volumes.
 - c. In Table of Contents and at least once in each Chapter or Section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using material or equipment model or catalog designations for identification is unacceptable.
2. Use dividers and labeled index tabs between equipment items and between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.
3. Each equipment item shall have an individual Cover Sheet with the following information:
 - a. Name or type of material or equipment.
 - b. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 - c. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 - d. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished as well as City Equipment Identification numbers, if applicable.
 - e. City Equipment Identification Numbers, if applicable.

1.4 ELECTRONIC REQUIREMENTS

- A. Electronic Copies of the Operation and Maintenance Manuals:
1. Each electronic copy shall include all information included in printed copy.
 2. Submit each electronic copy on a separate compact disc (CD), unless another electronic data transfer method or format is acceptable to ENGINEER.
 3. File Format:
 - a. The O&M Manuals will be placed into the OWNER's Content Management System. All electronic files shall be compatible with this system.
 - b. Files shall be in "portable document format (PDF)". Files shall be entirely electronically searchable and created from the original document. Scanned/Image PDF's will not be accepted.
 - c. Submit separate file for each separate document in the printed copy.
 - d. Within each file, provide bookmarks for the following:
 - 1) Each Chapter and Subsection listed in the printed copy document's table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix.
 4. Also provide drawings and figures in one of the following formats: ".bmp", ".tif", ".jpg", or ".gif". Submit files in a separate directory on the CD.
 5. Technical Drawings will be provided in both AutoDesk DWG format and PDF format.

1.5 CONTENT

- A. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
- B. Submit written explanations of all safety considerations relating to operation and maintenance procedures.
- C. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:

1. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
 2. Recommended schedule for each preventive maintenance task.
 3. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
 4. Table of alternative lubricants.
 5. Troubleshooting instructions.
 6. List of required maintenance tools and equipment.
 7. Spare parts.
- D. Complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-Drawing or per-equipment assembly basis. Bills of material shall indicate:
1. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 2. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 3. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
 4. For each part or piece include the following information:
 - a. Parts cross-reference number. Cross-reference number shall be used to identify the part on Assembly Drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
 - b. Part name or description.
 - c. Manufacturer's part number.
 - d. City Equipment Identification Number.
 - e. Quantity of each part used in each assembly.
 - f. Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.
- E. Complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.

- F. Manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two (2) years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
- G. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment. Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.
- H. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced Drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
- I. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
- J. Programmable Logic Controllers/Chiller Controller (Controllers):
 - 1. Submit complete logic listings in one (1) consistent format.
 - 2. Format Requirements:
 - a. For ladder diagram logic, include complete cross-referencing of all logic elements. Annotate all elements with clearly understandable tags or descriptive labels.
 - b. For function block diagram, label each function block with understandable tags or descriptive labels. Describe purpose and action of each function block.
 - c. For sequential function chart, include extensive comments for each step to describe program step function.
 - d. For instruction list and structured text, include extensive comments for each program line to describe program line function.
 - 3. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
 - 4. Submit complete manufacturer's programming manuals.
 - 5. Final versions of Chiller Controllers set-points, logic back-us and HMI screen settings.
- K. Copy of warranty bond and service Contract as applicable.

- L. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01810

START-UP AND COMMISSIONING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Commissioning Plan
- B. Functional Completion Testing
- C. Start-Up
- D. Commissioning
- E. Performance Testing
- F. Operational Demonstration

1.2 DEFINITIONS

- A. Commissioning: Commissioning is the series of activities or processes necessary to ensure that equipment and systems are designed, installed, functionally tested, started up and capable of being operated and maintained to perform in conformity with the design intent for the facility improvements. Commissioning includes, but is not limited to factory testing, field testing, dry testing, wet testing, performance testing, Manufacturer's checkout, and operational demonstration.
- B. Field Testing: Field testing is performance testing, operation testing, or documentation verification conducted in the field after installation, to provide comparison with the results obtained in the factory testing.
- C. Performance Testing: Performance Testing is testing performed by the CONTRACTOR to demonstrate the specified throughput of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees.
- D. Manufacturer's Checkout: Manufacturer's checkout shall be performed directly by the manufacturer. Checkout by the local equipment representative or salesman is not permitted. Checkout shall include, but not be limited to, wiring and power supply, installation, tolerances, clearances, rotation, etc.
- E. Start-up: Start-up shall be defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or systems with other equipment that is a part of the Facility. Start-up shall be performed by the CONTRACTOR, manufacturer, and local equipment representative.
- F. System: A "system" includes all required items of equipment, devices, and appurtenances connected so that their operation or function compliments, protects, or controls the operation or function of the others.

- G. Operational Demonstration: A commissioning activity performed by the CONTRACTOR wherein the CONTRACTOR operates and maintains a fully functional component system, unit process for a period of time after stable operation has been achieved. For purposes of this project, the period of time shall be 30-days, unless noted otherwise for specific pieces of equipment.
- H. Commissioning Plan: The Commissioning Plan incorporates all aspects of functional completion testing, startup, commissioning, performance testing, training, and reliability tests to ensure the facility operates properly and meets design intent and performance.

1.3 QUALITY ASSURANCE

- A. CONTRACTOR shall appoint a Performance Testing Manager who shall:
 - 1. Manage, coordinate, and supervise CONTRACTOR's start-up, testing, and commissioning activities including but not limited to field testing, performance testing with process liquids (cooling water), manufacturer's checkout and the Operational Demonstration.
 - 2. Assist in coordinating and documenting Site quality control work specified in individual Specification Sections.
 - 3. Prepare, or review and approve, all submittals for the work under this Section and related Work contained within the Contract Documents.
 - 4. Coordinate activities of subcontractors, manufacturers and suppliers relative to the start-up, testing, and commissioning activities.
- B. Performance Testing Manager shall be at the Site a minimum of eight (8) hours per day during all testing and be available at all times, 24 hours per day, seven (7) days per week to perform these duties.
- C. Performance Testing Manager shall supervise the CONTRACTOR's Operations ENGINEER and Operations Specialists who shall be dedicated to the start-up, testing, and commissioning Work.

1.4 SUBMITTALS

- A. Field Installation Reports – Submit reports by Manufacturer's Representative in accordance with the Contract Documents.
- B. Detailed Commissioning Plan – Submit detailed commissioning plan in accordance with the Contract Documents 90 days in advance of starting, testing and placing equipment into operation.
- C. Start up and Testing Documentation: CONTRACTOR shall prepare and submit all documentation for review and approval. The documentation shall include, but not be limited to, the following:
 - 1. Develop blank testing forms specific to each item of equipment or system to be filled out during start-up and testing.
 - a. All forms must be approved by ENGINEER and OWNER prior to use.

- b. Motor testing form shall at a minimum include flow, suction pressure, discharge pressure, amperage, voltage, and kW.
 2. Field testing plans that describe in detail the proposed testing procedures that will show the equipment and systems performance is in accordance with the requirements of the Contract Documents.
 3. Field testing reports including recorded test data, performance tolerances, observations, measurements taken, problems and modifications or corrective action taken for the equipment and systems to perform in accordance with the Contract Documents.
 4. Certification by the preparer that he/she is the person responsible for the data, and that the data is authentic and accurate.
 5. Certification by the CONTRACTOR or equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance, and that the equipment or unit process systems are suitable for Operational Demonstration in accordance with Section 01820 "Demonstration and Training."
- D. Develop performance testing plans and operational demonstration plans describing in detail, coordinated, sequential testing and demonstration of each system to be tested. Performance testing plan and operational demonstration plan shall be specific to the system or equipment item to be tested, and shall identify by specific equipment or tag number each device or control station to be manipulated or observed during testing, and specific results to be observed or obtained. Subcontractors and suppliers shall be present during testing, and for the planned testing duration. Performance testing plans and operational demonstration plans shall include:
 1. Summary of results of field testing.
 2. Calibration of all field instruments and control devices.
 3. Description of and information on temporary systems, equipment, and devices proposed for performance Testing and Operational Demonstrations, including calibration data for temporary instrumentation and controls.
 4. Description of data reduction required, if any, and proposed time between collection of data and submittal of results to ENGINEER.
 5. Summary of criteria for acceptance of test results. Summary shall include performance tolerances (if any) included in the Contract Documents. Where performance tolerances are not included in the Contract Documents, testing plans shall include proposed performance tolerances for approval by OWNER and ENGINEER.
 6. Following ENGINEER's approval of performance testing plans and operational demonstration plans, CONTRACTOR shall reproduce performance testing and operational demonstration plans in sufficient quantity for CONTRACTOR's purposes plus five (5) copies to ENGINEER and five (5) copies to OWNER. Do not start performance testing or operational demonstrations until required quantity of approved plans are provided.

- E. Testing Schedule: Provide a testing schedule that sets forth the planned sequence for performance testing and operational demonstration work. Testing schedule shall be part of the Progress Schedule and shall conform to requirements for Progress Schedule.
1. Detail the equipment and systems to be tested.
 2. Show planned start date, duration, and completion of each test.
 3. Testing schedule shall submitted no later than eight (8) weeks in advance of the date performance testing and operational demonstrations are to begin. ENGINEER will not witness performance testing and operational demonstration work until test schedule is accepted by ENGINEER.
 4. Testing schedule shall be updated weekly and resubmitted to ENGINEER. Updates shall indicate actual dates of performance testing and operational demonstration Work, indicating equipment, systems and treatment train for which testing is in progress, and that are satisfactorily completed in accordance with the Contract Documents.
- F. Following a successful Operational Demonstration, a summary report containing the following, at a minimum, shall be provided by the CONTRACTOR:
1. Equipment, systems and chillers and associated equipment started-up and commissioned.
 2. Start-up and commissioning dates.
 3. Equipment, systems and performance criteria tested, clearly showing requirements and field data that verifies requirements were met.
 4. Names of witnesses for start-up and commissioning.
 5. Any repairs, corrections, or modifications required for the equipment or unit process systems to successfully complete start-up and commissioning.
 6. Loop diagrams accurately depicting the installed condition of instrumentation and controls.
 7. Any other important Operational Demonstration information.
 8. Report Appendix containing the following, as a minimum:
 - a. A summary of all testing data used and calculations, including source, formulas with all terms defined.
 - b. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.
 - c. Production and operational data.
 - d. Calibration sheets for equipment.
 - e. Copies of calibration records for instrumentation.

1.5 COMMISSIONING PLAN

- A. The CONTRACTOR shall be responsible for preparing, coordinating, and executing the Plan.
1. The CONTRACTOR shall use the resources of the equipment and unit process systems suppliers in this work, particularly for specific equipment and unit process systems.
 2. An initial draft Plan for the Facility shall be completed and submitted by the CONTRACTOR to the ENGINEER for review at least 90 days prior to the expected commencement of commissioning. The ENGINEER will require 45-days to review the submittal and return with any exceptions noted. The CONTRACTOR shall incorporate the ENGINEER's comments into the revised Plan within 30-days of receiving comments and reissue the Plan to the ENGINEER and OWNER.
- B. The CONTRACTOR shall provide a dedicated field staff to support the Plan activities. A full-time Startup Manager shall be responsible for day to day activities and shall be the primary contact with the ENGINEER regarding Plan activities. Support staff shall include but not be limited to designated mechanical, electrical and instrumentation and control ENGINEERS and technicians, and operating staff.
1. The CONTRACTOR may require assistance from the OWNER's operating and maintenance staff in commissioning and performance testing activities specified herein. Activities requiring OWNER's staff shall be specifically noted in the Plan.
- C. The Plan shall define:
1. A chronological schedule of all testing and inspection activities.
 2. A checklist of all inspection and testing activities broken down by location, discipline, system, and device or item.
 3. All blank forms proposed by the CONTRACTOR for verification or recording of the functional completion testing, startup, commissioning and performance testing.
 4. An index which cross references the forms to their intended application(s).
 5. A list of all supplier certifications, including those required by the applicable technical specifications. Provisions shall also be included for retesting, in the event it is required.
 6. A list of participants in functional completion testing, startup, commissioning, and performance testing.
 7. A list of special test equipment required for functional completion testing, startup, commissioning, and performance testing.
 8. Sources of the test media (water, power, air.) for functional completion testing.
 9. The proposed method of delivery of the media to the equipment to be tested during functional completion testing, startup, commissioning, and performance testing.
 10. Temporary or interim connections for the sequencing of multiple units during functional completion testing, startup, commissioning, and performance testing.

- D. The CONTRACTOR shall designate, in the Plan, a Testing and Checkout Coordinator, to coordinate and manage the activities defined in the Plan.

1.6 ROLES AND RESPONSIBILITIES

- A. CONTRACTOR shall provide competent, qualified representatives of material, equipment, and system manufacturers to provide services specified, including supervising installation, adjusting, starting-up, and testing of materials and equipment.
- B. The CONTRACTOR shall provide all outside services, materials, labor, supplies, test equipment and other items necessary to perform the Testing, Startup and Commissioning specified herein. In addition, the CONTRACTOR shall arrange for and provide the participation or assistance of survey crews, quality control technicians, Supplier's representative(s), and required governmental agency representatives.
- C. The CONTRACTOR shall provide the services of the Supplier's representative(s) as follows:
 - 1. Assistance during installation as specified in Divisions 1 through 17 and as specified herein.
 - 2. Field Testing as specified in Divisions 1 through 17 and as specified herein.
 - 3. Startup as specified in Divisions 1 through 17 and as specified herein.
 - 4. Commissioning as specified in Divisions 1 through 17 and as specified herein.
- D. The Supplier's representative's activities required by this Section are in addition to the requirements for vendor training and other services specified elsewhere in the Contract Documents. Timing for the performance of these services is to be defined in the CONTRACTORS Checkout Plan, specified herein, and shall not be concurrent.
- E. The ENGINEER will review and comment on the CONTRACTOR's deliverables, participate in the physical inspection activities, witness the shop and field testing, witness functional testing, maintain the permanent record of all testing results, and provide verification of conformance to the specifications. The ENGINEER's right to perform inspections, witness tests or monitor or assess the work and activities does not relieve the CONTRACTOR of its obligation to comply with the requirements of the Contract Documents nor does it imply completion of the work.

1.7 FUNCTIONAL COMPLETION TESTING

- A. Functional Completion Testing shall be completed as construction and installation of equipment is completed to demonstrate that the equipment is ready for equipment and systems startup.
- B. Functional Completion Testing shall be done in a coordinated manner based on the Plan prepared by the CONTRACTOR.
- C. The OWNER's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.
- D. Functional Completion Testing procedures and documentation forms shall be developed by the CONTRACTOR. The procedures shall include a listing of items inspected for Functional Completion Testing.

- E. If any equipment or unit process systems do not meet Functional Completion Testing requirements, it shall be the responsibility of the CONTRACTOR and/or equipment suppliers to make the necessary corrections or replacements and repeat the test.
- F. The equipment and unit process systems shall not be started up or put into service until the Functional Completion Testing is completed as evidenced by a completed Functional Completion Testing certificate for the equipment or subsystem.
- G. Modifications to the equipment and unit process systems required to meet Functional Completion Testing requirements shall be provided, and all retesting shall be performed at no additional cost to the OWNER.
- H. A Functional Completion Testing Certificate shall be prepared by the CONTRACTOR for each piece of equipment or system and submitted to the ENGINEER and OWNER for review.

1.8 COMMISSIONING

- A. All equipment shall be commissioned.
- B. Commissioning activities for the project shall not be initiated until the requirements of Startup are completed for the equipment or unit process systems.
- B. The requirements of this Section shall be satisfactorily completed prior to beginning Performance Testing for equipment and unit process systems.
- C. Commissioning shall be used by the CONTRACTOR and equipment or unit process suppliers to adjust, fine tune, modify and prepare the equipment or system for continuous operation and Performance Testing.
- D. Equipment shall not be operated without the guidance of qualified personnel having the knowledge and experience necessary to conduct proper operation thereof and obtain valid results.
- E. All required adjustments, tests, operation checks, and Start-up and Commissioning activities shall be provided by qualified personnel.
- F. CONTRACTOR shall be responsible for planning, supervising, and executing the Start-up and Commissioning of the equipment and unit process systems with the assistance of equipment or unit process systems suppliers in accordance with the Plan.
- G. The CONTRACTOR shall be responsible for commissioning under the direction of its Start-up Manager.
- H. The OWNER's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.
- I. For equipment or unit process systems that do not meet Commissioning requirements, it shall be the responsibility of the CONTRACTOR and/or equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Commissioning at no additional cost to the OWNER.
- J. The equipment or unit process systems shall not be Performance Tested or otherwise placed into service until Commissioning is completed as evidenced by a completed Commissioning certificate for the equipment or unit process systems.

- K. Commissioning Certificates for each piece of equipment or unit process shall be completed and submitted by the CONTRACTOR to the ENGINEER and OWNER for review.

1.9 PERFORMANCE TESTING AND OPERATIONAL DEMONSTRATION

- A. CONTRACTOR shall demonstrate the operation of all equipment and systems. CONTRACTOR shall provide all labor, materials, services, equipment, and incidentals required for Performance Testing and Operational Demonstrations as indicated in the Contract Documents. This Performance Testing and Operational Demonstrations shall be conducted, coordinated and recorded by the CONTRACTOR in accordance with the requirements specified herein and in cooperation with the OWNER and ENGINEER.
- B. This Work is additional to any other installation, shop and factory testing, field testing, dry testing, wet testing, performance testing, balancing or adjustments required elsewhere in the Contract Documents.
- C. Conduct Performance Testing and Operational Demonstration testing for each item of process, mechanical, instrumentation and controls, chillers, condenser, electrical systems and equipment, and other systems and equipment, to demonstrate compliance with the performance requirements of the Contract Documents.
- D. Objectives of Performance Testing and Operational Demonstrations are to:
 - 1. Demonstrate to the satisfaction of the OWNER and ENGINEER that structures, equipment and systems tested comply with all functional and performance requirements in the Contract Documents.
 - 2. Establish baseline operating conditions for OWNER's use in establishing standard operating procedures and preventative maintenance programs.
 - 3. The Performance Testing shall maintain conformance with performance tolerances for a period of not less than seven (7) days. If a testing failure occurs (whether process, mechanical, electrical, instrumentation) during the seven (7) day testing period, the malfunction shall be repaired, and the seven (7) day testing period shall restart.
 - 4. The Operational Demonstrations shall maintain conformance with the performance tolerances for a period of not less than 30-days. If a testing failure occurs (whether process, mechanical, electrical, instrumentation) during the 30-day testing period, the malfunction shall be repaired, and the 30-day testing period shall restart.
- E. Sequence: The following general sequence applies to Performance Testing and Operational Demonstrations:
 - 1. Furnish submittals required prior to Performance Testing, in accordance with the Contract Documents.
 - 2. Furnish acceptable operations and maintenance manuals in accordance with the Contract Documents.
 - 3. Complete the Work associated with starting and placing equipment and systems in operation in accordance with the Contract Documents.

4. Training of operations and maintenance personnel in accordance with Section 01820, Demonstration and Training. Training must occur prior to the Operational Demonstration.
5. Proceed with Performance Testing in accordance with the Contract Documents, simulating the range of actual operating conditions to the greatest extent possible.
6. Complete site quality control Work specified in the Contract Documents for individual equipment items and systems. Field inspection, testing, and adjustments shall be signed off by approved representative of the Manufacturer, indicating that the equipment, components, systems, or unit processes meets the Manufacturer's requirements.
7. Following acceptance of the Performance Testing by the ENGINEER and OWNER, CONTRACTOR shall initiate a 30-day Operational Demonstrations, as described herein.
8. Successful completion of Operational Demonstration is part of the requirements to achieve Substantial Completion.
9. The Operational Demonstration for a piece of equipment shall be successfully completed prior to beginning the Operational Demonstration for a second piece of equipment.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 STARTUP

- A. The CONTRACTOR's Performance Testing Manager and Manufacturer's Representative shall inspect equipment and systems prior to each start-up and verify their readiness for start-up. Conditions hazardous to equipment or personnel shall be corrected by the CONTRACTOR's Performance Testing Manager prior to start-up of equipment.
- B. Start-up operations shall not precede using temporary power or temporary instrumentation and control wiring. All electrical and control connections shall be permanent and complete, and all such electrical components and equipment fully functional.
- C. Use of repair parts during start-up operations shall not be permitted, except in such situations where the actual on-site verification of such repair parts' operability is specified.
- D. The CONTRACTOR's Performance Testing Manager shall verify that all initial copies of the maintenance and operating instructions have received, from the ENGINEER, an acceptable disposition as defined in Section 01330, Submittal Procedures, and the only outstanding item is the field verification of the maintenance and operating instructions.
- E. CONTRACTOR's Performance Testing Manager shall compare, and make adjustments to conform to; the Manufacturer's recommendations for the following minimum start up requirements:

1. Motors:
 - a. Check each motor for comparison to amperage nameplate value.
 - b. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.
2. Valves:
 - a. Inspect manual and automatic control valves, and clean bonnets and stems.
 - b. Tighten packing glands to ensure no leakage, but allow valve stems to operate without galling.
 - c. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
 - d. Replace packing on valves that continue to leak.
 - e. Remove and repair bonnets that leak.
 - f. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".
 - g. Verify that control valve seats are free from foreign matter and are properly positioned for intended service.
3. Tighten flanges and other pipe joints after system has been placed in operation.
 - a. Replace gaskets that show signs of leakage after tightening.
4. Inspect all joints for leakage:
 - a. Promptly remake each joint that appears to be faulty; do not wait for rust or other corrosion to form.
 - b. Clean threads on both parts, and apply compound and remake joints.
5. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.
6. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.
7. Inspect fan wheels for clearance and balance.
8. Check each electrical control circuit to ensure that operation complies with the Contract Documents.
9. Inspect each pressure gauge, thermometer, and other instruments for calibration.
 - a. Replace items that are defaced, broken, or that read incorrectly.

10. Repair damaged insulation.
11. Vent gasses trapped in systems.
12. Verify that liquids are drained from all parts of gas or air systems.

3.2 COMMISSIONING

- A. On successful completion of startup, the CONTRACTOR shall begin commissioning of the equipment and systems, wherein the equipment and systems are subjected to full operation. Adjustments shall be made as necessary and the equipment and system shall be optimized and brought into compliance with design criteria in preparation for performance testing and the Operational Demonstration specified within the Contract Documents.
- B. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Commissioning services for the new facility.
- C. The CONTRACTOR shall coordinate all Commissioning activities for equipment and systems in accordance with the accepted commissioning plan.
- D. Commissioning shall show that the equipment and unit process systems are capable of continuous operation and that the flows, operating parameters and performance requirements have been demonstrated for a minimum of seven days of continuous operation, or the period required in the equipment specifications, whichever is longer.
- E. If the commissioning fails, the CONTRACTOR will be responsible for redoing the commissioning at no additional costs to the OWNER.
- F. Shutdowns that occur because of power outages, acts of God, or failure of support systems not part of this Contract will not be a cause of failure of continuous operation during the Operational Demonstration.

3.3 PERFORMANCE TESTING AND OPERATIONAL DEMONSTRATION

- A. CONTRACTOR shall perform Operational Demonstration of the work. Unless otherwise specified, the Operational Demonstration shall be a continuous 30-day, (720 hours) period during which the work is operated and maintained in a continuously on-line, fully functional process status.
- B. The Operational Demonstrations shall encompass the entire work of each chiller, or the portion thereof designated for Substantial Completion. The Operational Demonstrations shall include all the equipment and systems.

The 40-ton chiller will be fully functional and commission prior to work commencement on the 100-ton chiller.
- C. Filling, draining, cleaning, stabilizing, adjusting, or other start-up activity time shall not be counted as Operational Demonstration time.
- D. During the entire 30-day Operational Demonstration period, the operation of equipment will be assumed by the OWNER's personnel, under the direction of the CONTRACTOR. The CONTRACTOR shall provide labor and sufficient material to fully operate and maintain the work 24 hours per day, seven (7) days per week for the entire duration of the Operational Demonstrations.

- E. Prior to the Operational Demonstrations, all parts of the work designated for the operational demonstration shall have passed all required tests as specified. No testing shall be allowed during the Operational Demonstrations.
- F. During the Operational Demonstration period, CONTRACTOR shall obtain baseline operating data on equipment with motors greater than one horsepower. Baseline data shall include amperage, bearing temperatures, and vibration data obtained at intervals in the approved testing plan. Methods of measurement shall be in accordance with industry standards applicable for the motors being tested.
- G. All required maintenance and servicing prior to the date of Substantial Completion shall be performed by the CONTRACTOR at the specified interval and as necessary. All maintenance and servicing shall be noted in the Operational Demonstration Log.
- H. All outages of equipment or system(s) should be noted in the Operational Demonstration Log. Plant outages are considered a part of normal plant operation and will not invalidate the Operational Demonstration. The CONTRACTOR is responsible for the safe and orderly shutdown and restart of equipment as necessary in the event of an outage.
- I. CONTRACTOR and Performance Testing Manager shall attend Operational Demonstration coordination meetings as called by the ENGINEER to review operating conditions of equipment and systems.
- J. If during the Operational Demonstration, any part of the work fails to fully conform to the requirements of the Contract Documents, the Operational Demonstration shall be considered to have failed, and the work shall not be considered to be Substantially Complete, and the ENGINEER shall so notify the CONTRACTOR in writing. If, during the Operation Demonstration, the provisions of the General Conditions are evoked to stop the work, the Operational Demonstration will also be considered to have failed.
- K. Re-testing Because of Disputed Testing Results or Procedures: In the case of an otherwise satisfactory Operational Demonstration, when there is doubt, dispute, or difference between ENGINEER and CONTRACTOR regarding testing results, methods, or equipment used in the Operational Demonstration testing, ENGINEER may order CONTRACTOR to repeat the testing. If repeat testing using such modified methods or equipment required by ENGINEER confirms the previous test, all costs of repeat test will be paid by OWNER. Otherwise all costs, including costs of the ENGINEER, labor, testing agencies, and inspections, shall be paid by CONTRACTOR.
- L. Post-test Inspection: After completing Operational Demonstration testing, check equipment for proper alignment and realign, as required. Check equipment for loose connections, unusual movement, and other indication of improper operating characteristics. Disassemble and inspect equipment and devices that exhibit unusual or unacceptable operating characteristics. Repair or replace defective Work to conform to the Contract Documents at no additional cost to OWNER.
- M. Upon failure of the Operational Demonstration, the CONTRACTOR shall promptly remedy any defects in the work and shall promptly reschedule and re-start the complete 30-day, (720 hours) Operational Demonstration time period. No Operational Demonstration time will be considered to have accrued to any part of the work by reason of a failed Operational Demonstration.
- N. During the Operational Demonstration, the OWNER may require or permit the Operational Demonstration to be suspended:
 - 1. As provided in the General Conditions.

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2. Upon the written request of the CONTRACTOR, to correct or adjust the work, when in the judgment of the ENGINEER such required correction or adjustment is insufficient to deem the Operational Demonstration to have failed.
 3. If the Operational Demonstration is suspended for any reason except failure, Operational Demonstration time shall accrue to the work from the time of the beginning of the Operational Demonstration to the time of the suspension.
 4. If the Operational Demonstration is suspended at the request of the CONTRACTOR, the CONTRACTOR shall continue operation and maintenance of the work without additional charges to the OWNER, according to the extent required by the Contract Documents and the OWNER. No Operational Demonstration time shall accrue to the Work during the period of suspension.
- O. Completion of the Operational Demonstration does not relieve the CONTRACTOR of its other requirements for Substantial Completion as required by the Contract Documents.

END OF SECTION

SECTION 01820

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Training
- B. Instructor Manual
- C. Trainee Manual

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittal Procedures:
 - 1. Submit two (2) copies of the outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 2. Submit resumes, including three (3) outside references, for each instructor proposed for training program. The qualifications of the instructor shall include the type of training instructor has received for the specific equipment and previous training work experience.
 - 3. Submit two (2) electronic copies of each training module within seven (7) calendar days following the delivery of each training module. Submit copies 30-days prior to training.
 - 4. On each copy of the training module, provide an applied label with the following information:
 - a. Name of Project
 - b. Training Session Name
 - c. Name of ENGINEER
 - d. Name of Construction Manager
 - e. Name of CONTRACTOR
 - 5. At completion of training, submit complete training manual(s) for OWNER's use prepared and bound in format matching operation and maintenance manuals and in a PDF electronic file. Include a table of contents with links to corresponding training components.
 - a. The PDF electronic file format shall be electronically searchable and shall adhere to the same requirements defined in Section 01781, Operation and Maintenance Data, Paragraph 1.4.

1.3 COORDINATION

- A. CONTRACTOR to coordinate instruction schedule with OWNER's operations. Adjust schedule as required to minimize disrupting OWNER's operations and to ensure availability of the OWNER's personnel. CONTRACTOR shall schedule training sessions at least sixty (60) days in advance.

- B. CONTRACTOR shall provide a minimum of three (3) general training sessions. Each of the training sessions shall cover all topics. General training sessions may be on non-consecutive weeks to accommodate shift changes at the plant.
- C. Detailed instrumentation and controls training shall be provided separately in accordance with Section 17720, Computerized SCADA System. This training will include any system related to the Chiller control package.
- D. Training sessions shall be provided prior to the operational demonstration.
- E. CONTRACTOR to coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- F. CONTRACTOR to coordinate content of training modules with content of accepted emergency, operation, and maintenance manuals. Do not submit instruction program(s) for review until the operation and maintenance data required under Section 01781 has been reviewed and accepted by ENGINEER.

PART 2 - PRODUCTS

2.1 INSTRUCTOR MANUAL

- A. The CONTRACTOR shall prepare an Instructor Manual or each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanical specialists and instrument technicians, and for water treatment plant operators, or other disciplines, depending upon the target audience.
- B. The Instructor Manual shall be consistent with the nomenclature and contents of the accepted CONTRACTOR's O&M Manuals required in Specification Section 01781. The O&M Manuals cannot be substituted for the Instructor Manual.
- C. The purpose of the Instructor Manual is to define the concepts and information that will be taught to each target audience and to describe the methods and materials to be used during the training. The Instructor Manual is designed to provide specific guidance to the Instructor regarding all aspects of the training program. The Instructor Manual shall include:
 - 1. Description of the equipment.
 - 2. Parts and equipment graphics.
 - 3. Safety procedures.
 - 4. Startup checks and procedures.
 - 5. Overview of routine operation, including startup and shutdown and operating parameters.
 - 6. Routine, preventive, and corrective maintenance procedures.
 - 7. Lubrication (schedule and type).
 - 8. Assembly and disassembly procedures.

9. Troubleshooting procedures.
 10. Parts list.
 11. Special maintenance practices.
 12. Emergency shutdown.
- D. All manuals shall be presented in electronic format per the requirements of Specification Section 01330. All equipment shall be cross-referenced to the equipment tag identification numbers.
- E. Each Instructor Manual shall contain:
1. Instructor Manual cover page.
 2. Instructor Manual table of contents.
 3. Lesson Plan cover page.
 4. Lesson Plan summary.
 5. Lesson Plan text, including:
 - a. Identity of the target audience (a separate Lesson Plan is required for each target audience, such as mechanical O&M personnel, electronic/electrical O&M personnel, etc.).
 - b. Length of the training program and each topic to be covered.
 - c. Performance and/or training objectives.
 - d. Outline of the material to be covered.
 - e. Training strategies to be used and interaction with the trainees.
 - f. Audio visual and/or support materials required, and when used or referred to during instruction.
 - g. A list of resource and/or reference materials.
 6. A copy of all training aids, including electronic files.
 7. A copy of trainee materials (handouts, reference materials, etc.) in electronic format.
- F. The CONTRACTOR shall submit the equipment manufacturer's lesson plans for acceptance by the ENGINEER no less than 90-days prior to the date that the training is to take place.
- G. With the exception of cutaway models or other items expressly exempted by the ENGINEER, all training aids and trainee materials contained in the Instructor Manual or used in the delivery of training shall become the property of the OWNER and may be duplicated by the OWNER for its own use.

- H. The CONTRACTOR shall provide required acceptance and/or copyright releases obtained from those who own proprietary and/or copyrighted materials provided by the CONTRACTOR so that the materials can be reproduced by the OWNER.

2.2 TRAINEE MANUAL

- A. Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required in the individual Specification Sections.
- B. The CONTRACTOR shall submit a Trainee Manual for each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanic specialists and instrument technicians, and for water treatment plant operators, or other disciplines, depending upon the target audience.
- C. The Trainee Manual shall be consistent with the nomenclature and content of the accepted CONTRACTOR O&M Manuals required in Specification Section 01781. The O&M Manual cannot be substituted for the Instructor Manual or Trainee Manual.
- D. The purpose of the Trainee Manual is to provide an organized package of information for use by trainees during the training sessions and as reference Water Treatment Plant (New) material for operation and maintenance in the future. The Trainee Manual shall include:
 - 1. Description of the equipment.
 - 2. Parts and equipment graphics including “exploded” views.
 - 3. Safety procedures.
 - 4. Pre-startup checks.
 - 5. Startup procedures.
 - 6. Operation and monitoring procedures including normal operating parameters, and the operating limits of the equipment.
 - 7. Shutdown procedures.
 - 8. Troubleshooting procedures.
 - 9. Non-routine emergency procedures.
 - 10. Safety/Protective equipment required by Trainees.
- E. All manuals shall be presented in electronic format per the requirements of Specification Section 01330. All equipment shall be cross-referenced to the equipment tag identification numbers.
- F. The CONTRACTOR shall provide at least one hard copy of each Trainee Manual for each trainee. Hard copies shall be on 8.5” x 11” paper in a 3-hole D-ring binder.

PART 3 - EXECUTION

3.1 FACILITIES FOR TRAINING

- A. Use OWNER's designated training facilities for specified field training programs. Facilities shall include the project site, which shall be used for hands-on training programs. Coordinate use of OWNER's facilities with OWNER.

3.2 TRAINING

- A. Training shall include the following:
 - 1. Equipment Overview (required for all types of operations and maintenance training):
 - a. Describe equipment's operating (process) function and performance objectives.
 - b. Describe equipment's fundamental operating principles and dynamics.
 - c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
 - d. Identify all support equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
 - e. Identify and describe safety precautions and potential hazards related to operation.
 - f. Identify and describe in detail safety and control interlocks.
 - 2. Operations Training:
 - a. Describe operating principles and practices.
 - b. Describe routine operating, start-up, and shutdown procedures.
 - c. Describe abnormal or emergency start-up, operating, and shutdown procedures that may apply.
 - d. Describe alarm conditions and responses to alarms.
 - e. Describe routine monitoring and recordkeeping procedures.
 - f. Describe recommended housekeeping procedures.
 - g. Describe how to determine if corrective maintenance or an operating parameter adjustment is required.

3. Maintenance Training:
 - a. Describe preventative maintenance inspection procedures required to: inspect equipment in operation, identify potential trouble symptoms and anticipate breakdowns, and forecast maintenance requirements (predictive maintenance).
 - b. Define recommended preventative maintenance intervals for each component.
 - c. Describe lubricant and replacement part recommendations and limitations.
 - d. Describe appropriate cleaning practices and recommend intervals.
 - e. Identify and describe use of special tools required for maintenance of equipment.
 - f. Describe component removal, installation, and disassembly and assembly procedures.
 - g. Perform “hands-on” demonstrations of preventive maintenance procedures.
 - h. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
 - i. Define recommended torqueing, mounting, calibrating, and aligning procedures and settings, as appropriate.
 - j. Describe recommended procedures to check and test equipment following corrective maintenance.
 4. Equipment Troubleshooting:
 - a. Define recommended systematic troubleshooting procedures.
 - b. Provide component-specific troubleshooting checklists.
 - c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.
 - d. Describe common corrective maintenance procedures with “hands on” demonstrations.
 5. Instrumentation/Controls Training:
 - a. Instrumentation and controls training shall be provided in accordance with Section 17720, Computerized SCADA System.
- B. Equipment to be covered during training shall be per the requirements of the individual sections of the Contract Documents. A list of required training topics is listed in Table 01820-A, Training Summary Table.

01820-A, Training Summary Table

Equipment	Specification Section
Chiller	15511, 15513
Piping	15102
Condenser	15512
Controls	15950, 15951

3.3 SCHEDULE

- A. The CONTRACTOR shall coordinate the manufacturer's training services with the OWNER and the ENGINEER, providing a minimum of sixty (60) days prior notice of training, subject to the acceptance of the ENGINEER and the OWNER.
- B. Training shall occur prior to the operational demonstration.
- C. A training session for all equipment items shall be performed and completed in four (4) – four (4) hour sessions.
 - 1. Session "A" will be during commissioning of the 40-ton chiller.
 - 2. Session "B" will be 21 days after final commissioning of the 40-ton chiller
 - 3. Session "C" will be during commission of the 100-ton chiller
 - 4. Session "D" will be 21 days after final commissioning of the 100-ton chiller.

All dates will be confirmed with OWNER prior to scheduling.

END OF SECTION

SECTION 15010

MECHANICAL BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Basic materials and methods and related items for heating, ventilating, air conditioning systems and plumbing systems.

1.2 RELATED DOCUMENTS

- A. General Conditions and requirements of Division 1 apply to Work of this Section.
- B. Related work specified in other Division 15 Sections.

1.3 SUBMITTALS

- A. Submit under provision of Section 01330, Submittal Procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver new, unused materials to the job site in original, unbroken factory packaging.

PART 2 – PRODUCTS

2.1 MECHANICAL PIPING & FITTINGS

- A. Provide mechanical piping and fittings per the specification.
- B. Mechanically formed tee connections in copper piping.
 - 1. Contractor may use mechanically formed Tee connections in copper piping in lieu of tee fitting only where main piping is 2 1/2" or larger and where branch connection is 3/4" or smaller. Joint must be brazed. Tool manufacturer: T-Drill.

2.2 UNIONS AND COUPLINGS

- A. Size 2 inch and under: 300 psi malleable iron, bronze to iron ground joint unions for threaded ferrous piping. Provide wrought copper or brass couplings for copper piping. Provide brass unions for all ferrous to copper piping connections.
- B. Size 2-1/2 inch and over: 150 psi forged steel slip-on flanges for ferrous piping and 150 psi bronze flanges for copper piping. Gaskets: 1/8 inch thick, preformed synthetic rubber with impregnate cloth suitable for service intended, high temperature type, 286°F.
- C. Use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some annular deflection, contraction and expansion. Couplings consist of malleable iron housing-clamps, C-shaped composition sealing gasket and steel bolts. Use galvanized couplings for galvanized pipe. For di-electric connection in grooved piping, use manufacturer's di-electric nipple. Manufacturers: Grinnell/Gruvlok Di-Lok Nipple, Victaulic Style 47 Di-electric Waterway.

- D. Unions shall be installed preceding and after each control valve, strainer, pump, coil & any other piece of equipment to enable removal.
- E. Di-electric unions are not allowed, unless noted otherwise.

2.3 BOLTS, STUDS AND NUTS

- A. Steel bolts, studs, and nuts: Comply with the current ASTM A-307, Grade B, or equal.
- B. Threads: American National form right hand machine cut threads complying with the current American Standard for Screw Threads ANSI B1-1, Coarse Thread Series, Class 2 fit.
- C. Provide zinc plated carbon steel bolts and nuts for flanged pipe joints.
- D. Provide stainless steel Type 304 bolts and nuts for underground pipe joints, for all bolts set into concrete, for all bolts securing mechanical equipment, and for all exterior/rooftop bolts
- E. Bolt heads and nuts: Semi-finished, hexagonal, complying with the dimensions for the current American Standard for Wrench Head Bolts and Nuts and Wrench Openings, ANSI B18.2, Heavy Series.

2.4 PIPE SLEEVE

- A. Provide pipe sleeve for all new piping thru existing or new building construction.
- B. Material: Seamless pipe, galvanized, ASTM A120 for penetrations through outside walls and floors, unless noted otherwise. Provide seamless, black steel ASTM A53 elsewhere, unless noted otherwise.
- C. Sleeve Size: Large enough to accommodate the pipe, link seal, and its covering, wall sleeves to be flush on both sides, and floor sleeves to be extended 2 inch above floor level. Where escutcheon plates are required, extend the sleeves 1/4 inch above the floor.
- D. Modular mechanical type seal: Use for the annular space between pipes and sleeves to seal against water or earth, consisting of interlocking synthetic rubber links compressed to positive seal by through bolts bearing on delrin plastic pressure plates. Provide 316 stainless steel bolts. Provide linkseal by PSI/ Thunderline.

2.5 VALVES

- A. General
 - 1. All valves shall comply with the applicable Manufacturers Standardization Society of the Valves and Fittings Industry.
 - 2. All valves shall have fullport openings and be of the serviceable type.
 - 3. Manually operated valves used in fuel systems shall have levers with locking devices.
 - 4. Manually operated valves 10 feet A.F.F. or higher shall have chain wheel operators with chains reaching to within 4'-0" A.F.F.
 - 5. Unless otherwise noted, valves shall be rated for a minimum of 125 psi W.S.P/250 psi (cold water, oil, gas).

6. Valves through 2" shall have screwed connections for steel piping and sweat connections for copper piping. Valves 2-1/2" and larger shall be flanged. Grooved connections are permitted where specified.
7. Gate valves shall be repackable under pressure whether open or closed.
8. Provide extended valve stems for insulated piping.
9. Where valves are installed outdoors, all components including the gear wheel operators shall be weatherproofed.
10. Unless noted otherwise, all butterfly valves shall be full lug construction, suitable for bi-directional dead end service, and have open position memory stop. Manually operated butterfly valves 4" and larger shall have enclosed worm gear operators with position indicators.
11. Unless noted otherwise, valves shall be same size as piping.

B. Shut-Off Valve and Check Valve Application Schedule (unless noted otherwise on drawings or specifications)

System	Shut-Off Valve and Check Valve Type and Size		
	2" and Less	2" - 4"	6" and Larger
Cold Water	A, E	B, F	B, F
Natural Gas	A	G	G

C. Shut-Off Valve and Check Valve Types

1. Type A: Ball Valves provide 2-piece, full port, bronze body, stainless steel ball and stem with PTFE seats. Valves for natural gas shall be AGA approved.
2. Type B: High Performance Butterfly Valves, provide iron body, PTFE seat, one-piece stainless steel shaft and bearing, 316 stainless steel disk, Teflon stem packing, memory stop and lug pattern rated for 150 psi, 450 degrees F., ANSI class.
3. Type C: Standard Butterfly Valve, full lug, carbon steel body, stainless steel disc, shaft and bearing, EPDM seat, Teflon stem packing. Rated for 125 psi, 250 degrees F.
4. Type D: Gate Valve, bronze body and trim, screwed, rising stem, double wedge or disc. Deep stuffing box with gland and back seating capacity.
5. Type E: Swing Check Valve, bronze body and trim.
6. Type F: Silent Check Valve, proved stainless steel spring loaded, resilient disc, silent type, bronze body.
7. Type G: Lubricated Plug Valve, semi-steel body, single gland, wrench operated, flanged ends, MSS SP-78, 175 psi.

D. Drain Valve

1. Ball valve with 3/4" hose thread and cap. Bronze body, stainless steel ball and stem.

E. Water Pressure Regulating Valve

1. Bronze valve body, renewable stainless steel seat. Adjustable reduced pressure range, built-in bypass, diaphragm type with spring cage and orifice. Pressure to be adjustable from a top screw on the valve. Valve to comply with ASSE Standard 1003.

F. Water Pressure Relief Valves

1. ASME rated, sized for the full installed capacity of the low pressure side of the regulating station. Factory set valve at not more than 20% above low side pressure. Furnish seat material suited for the service.

2.6 STRAINERS

- A. Body shall be bronze, cast steel or cast iron, to match piping materials. Strainers shall be same size as piping, with screwed connections on piping 2" and smaller, and flanged connections on piping 2-1/2" and larger. Where grooved piping is specified, grooved joint strainers may be used. Screen area shall be twice internal area of piping. Pressure rating shall be that of piping system, minimum 125 lbs. Provide 3/4 ball valve blow down valve on all strainers 2" and larger.
- B. For water screen material shall be stainless steel, with maximum openings of 0.033" (maximum) for pipes 2" and smaller and 3/64" for pipe sizes 2-1/2" and larger.
- C. For air and gas service, screen material shall be stainless steel, with maximum openings of 0.006" (maximum) for pipes 2" and smaller and 0.009 for pipe sizes 2-1/2" and larger.

2.7 FLEXIBLE METAL HOSE CONNECTORS:

- A. Length and end fittings as shown in drawings, with an inner corrugated hose made of type 304, 321, or 316 stainless steel and outer braid made of 304 stainless steel.
- B. For copper piping systems, use copper construction braided hoses.
- C. Connectors shall be rated for minimum 125 psi and 450°F.

2.8 FIRE STOPPING

- A. Provide UL classified fire stopping system for mechanical penetrations through rated walls and floors to maintain the fire rating.
- B. Manufacturers: TREMCO Fyrshield, Manville Duxseal, 3M.

2.9 ACCESS PANELS

- A. Furnish access panels to access valves, traps, control valves or devices, dampers, damper motors, etc. Access panels shall be sized as necessary for ample access, or as indicated on drawings, but no smaller than 12" x 12" where devices are within easy reach of operator, and at least 24" x 24" when operator must pass through opening in order to reach the devices. Architectural Trades shall install access panels coordinated with Mechanical Trades.
- B. Access panels in fire rated walls or ceiling must be U.L. labeled for intended use. Unless otherwise indicated on plans, access doors shall be hinged flush type steel framed panel, 14 gauge minimum for frame, and with anchor straps. Only narrow border shall be exposed. Hinges shall be concealed type. Locking device shall be flush type and screw driver operated. Metal surfaces shall be prime coated with rust-inhibitive paint. Panels shall be compatible with architectural adjacent materials. Color by Owner.

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2.10 EQUIPMENT MOTORS

- A. Provide motors with all motor driven equipment, complete with drives and controls. Electrical starters will be provided by electrical trade unless part of packaged equipment. See equipment specifications.
- B. All motors used shall conform to all applicable requirements of NEMA, IEEE, ANSI & NEC standards. All motors shall comply with:
 - 1. NFPA 70, "National Electric Code", 1999.
 - 2. NEMA MG-1, "Motors and Generators", 1998.
 - 3. UL 1004, "Motors, Electric".
- C. General
 - 1. Frequency Rating: 60 Hz.
 - 2. Voltage rating of motor shall be determined by voltage of circuit to which motor is connected.
 - 120 V Circuit: 115 V - motor rating
 - 208 V Circuit: 200 V - motor rating
 - 240 V Circuit: 230 V - motor rating
 - 480 V Circuit: 460 V - motor rating
 - 3. Temperature Rise: Based on 40 degree ambient except as otherwise indicated.
 - 4. Service Factor: 1.15 unless noted otherwise.
- D. Three Phase Motors
 - 1. General: Energy Efficient, squirrel-cage induction-type, NEMA Design B conforming to the following requirements except as otherwise indicated.
 - 2. Enclosure: Totally Enclosed Fan Cooled (TEFC) unless otherwise noted in equipment specifications and schedules.
 - 3. Motor Efficiency: Nominal (nameplate) full load efficiency and corresponding minimum efficiency equal to or greater than that stated in NEMA MG-1, Table 12-10 for that type and rating of motor.

NEMA TABLE 12-10 - ENERGY EFFICIENT MOTORS
NOMINAL FULL LOAD EFFICIENCIES

Horse-power	Open Drip Proof (ODP)			Total Enclosed Fan Cooled (TEFC)		
	2-Pole 3600 rpm	4-Pole 1800 rpm	6-Pole 1200 rpm	2-Pole 3600 rpm	4-Pole 1800 rpm	6-Pole 1200 rpm

Horse-power	Open Drip Proof (ODP)			Total Enclosed Fan Cooled (TEFC)		
	2-Pole 3600 rpm	4-Pole 1800 rpm	6-Pole 1200 rpm	2-Pole 3600 rpm	4-Pole 1800 rpm	6-Pole 1200 rpm
1.0		82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2.0	84.0	84.0	85.5	84.0	84.0	86.5
3.0	84.0	86.5	86.5	85.5	87.5	87.5
5.0	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10	88.5	89.5	90.2	89.5	89.5	89.5
15	89.5	91.0	90.2	90.2	91.0	90.2
20	90.2	91.0	91.0	90.2	91.0	90.2
25	91.0	91.7	91.7	91.0	92.4	91.7
30	91.0	92.4	92.4	91.0	92.4	91.7
40	91.7	93.0	93.0	91.7	93.0	93.0
50	92.4	93.0	93.0	92.4	93.0	93.0
60	93.0	93.6	96.6	93.0	93.6	93.6
75	93.0	94.1	93.6	93.0	94.1	93.6
100	93.0	94.1	94.1	93.6	94.5	94.1
125	93.6	94.5	94.1	94.5	94.5	94.1
150	94.5	95	94.5	94.5	95.0	95.0
200	94.5	95	94.5	95.0	95.0	95.0

4. For motors used with variable speed drives, provide inverter duty motors in accordance with NEMA MG-1 Part 31, with insulation Class F and insulation temperature rise rating of Class B.

E. Single-Phase Motors

1. Provide internal thermal overload protection for motors.

F. Manufacturers

1. Motors 2 HP and larger shall be manufactured by one of the following: Reliance, Baldor, Dayton, Toshiba, General Electric, U.S. Motor.

2. Requirements in other Sections shall apply.

2.11 ACCEPTABLE MANUFACTURERS

A. Caulking

1. Interchem Presstite
2. Foster Sealer

B. Hatches with safety grating

1. ITT

- 2. Bilco
- C. Flexible Connectors in Pipe
 - 1. Flexonics
 - 2. Twin City Hose
 - 3. Metraflex
 - 4. Mason
- D. Pipe Thread Sealing Compound
 - 1. Teflon Seal Tape-Jomar
 - 2. Teflon Dope-Jomar "Gimme the Teflon Stuff"
 - 3. Teflon Whitlam T-U Type 555
- E. Couplings
 - 1. Dresser w/ S.S. Hardware
- F. Pressure Gauges
 - 1. Terice
- G. Pressure and Temperature Plugs
 - 1. Pete's Plug
 - 2. Schrader
 - 3. Sisco
- H. Strainers
 - 1. Mueller
 - 2. Armstrong
 - 3. Grinnell
 - 4. Conbraco Industries
 - 5. Metraflex
 - 6. Spirax-Sarco
 - 7. NIBCO
 - 8. Watts
- I. Thermometers (Industrial Grade)
 - 1. Ashcroft
 - 2. Terice
 - 3. Weiss Instruments
 - 4. Weksler
- J. Vacuum Breakers
 - 1. Hoffman
 - 2. Watts
 - 3. Zurn
- K. Ball Valve
 - 1. Jomar S-100-SS and T-100-SS
 - 2. NIBCO S-585-70-66

- 3. Watts B-6081-SS
- 4. Grinnell 3700-6 and 3700-SJ-6

L. Swing Check Valve

- 1. Milwaukee 509
- 2. Crane 37
- 3. Grinnell 3300
- 4. NIBCO

M. Silent Check Valve

- 1. APCO 300
- 2. Milwaukee Series 1400
- 3. Keystone Prince
- 4. Grinnell Series 400

N. High Performance Butterfly Valve

- 1. Dezurik BHP
- 2. Keystone K-LOK 32
- 3. Grinnell WINN
- 4. Watts QF Series X

O. Standard Butterfly Valve

- 1. Grinnell Series 8000
- 2. Dezurik BRS
- 3. Keystone Model K-LOK 312
- 4. NIBCO Series 2000 or 3000
- 5. Watts Series BG

P. Gate Valves

- 1. Grinnell 3090
- 2. NIBCO T134
- 3. Crane 428

Q. Water Pressure Regulating Valves

- 1. Watts
- 2. Bell & Gossett Model 350
- 3. Conbraco
- 4. Wilkins

R. Water Pressure Relief Valves

- 1. Bell & Gossett
- 2. McDonnell Miller
- 3. Watts

S. PVC/CPVC Pipe, Fittings & Valves

- 1. Orion
- 2. Enfield
- 3. Spears

PART 3 – EXECUTION

3.1 INSTALLATION

- A. For soldered joints, use non-acidic and lead-free flux on cleaned pipe and fittings. Cut pipe square and ream ends before assembly. Fill joints with solder by capillary actions, with solder covering joint periphery. Wipe joints clean. Apply heat carefully to prevent overheating and damage to pipe, fittings, and valves. Strict adherence to manufacturer's installation recommendations when heating and soldering valves is mandatory.
- B. Terminal units shall be properly supported to wall studs by use of backing plate spanning stud-to-stud.
- C. Cut copper tube square and ream before assembly. Keep piping capped during construction to prevent intrusion of construction debris.
- D. Support piping drops through finished ceiling from structure above to prevent any lateral or up/down movement. Other outlet drops shall be supported from walls, columns, or work benches using appropriate hangers, anchors, or unistrut.
- E. CONTRACTOR shall provide his own survey to locate pipes, elevations, ducts, conduits, etc. and prepare his own shop drawings. Variations to suit existing conditions, structural features or mechanical equipment shall be his responsibility.
- F. Cut pipe accurately and install without springing or forcing. All burrs shall be removed after cutting.
- G. Install plumbing to applicable code requirements.
- H. Install all domestic supply piping for fixtures through the sidewalls unless otherwise noted on the Plans.
- I. Install shock absorbers on the water supply at flush valves or self-closing valves and at equipment with solenoid valves.
- J. Install above ground water piping so as to be completely drainable with accessible drain valves installed at the low points of the system.
- K. Lubricate domestic clean out plugs with mixture of graphite and linseed oil.
- L. Install chrome-plated compression stops for all fixtures.
- M. Make screwed joints with full cut standard taper pipe threads.
- N. Install piping to permit complete draining. Provide capped hose end ball drain valves at all low points.
- O. Installed piping shall be free from sagging. Provide for expansion and contraction of piping in an approved and safe manner by means of loops or offsets, where mechanical expansion joints are not specifically called for.
- P. Branch connections for gaseous systems shall be taken off mains on top, up at a 45E angle, or off the side.
- Q. Branch piping shall be valved at the branch connection points.

- R. Provide fittings and specialties necessary to properly interconnect all items and specialties whether or not shown in detail.
- S. Clean and swab-out all piping before installation. Piping left open for extended periods shall be capped.
- T. Lay out pipe lines straight, plumb and in true alignment. Offset as required to avoid interference with other work, to conceal piping, to allow maximum headroom and to avoid interference with windows and doors. Lay out all pipes and establish their levels from bench marks, existing floors or finished grades.
- U. Piping shall be concealed unless indicated otherwise on drawings. Do not conceal piping until it has been inspected, tested, flushed and approved.
- V. Route pipes in groups where possible.
- W. Run pipes perpendicular and parallel to building walls.
- X. Use eccentric reducing fittings to increase or decrease pipe sizes. Bushings are not acceptable. Orient reducers to prevent trapping of water.
- Y. Pipe extending into finished areas shall have chrome plated escutcheons large enough to cover pipe sleeves and shall fit snugly over pipe or insulation.
- Z. Pitch piping as follows (unless noted otherwise):
 - 1. Vent piping back toward waste at 1/16" per foot.
 - 2. Waste, and compressed air piping down in direction of flow at 1/8" per foot.
 - 3. Natural gas piping level or at 1/4" per 15 foot toward drip leg.

3.2 INSTALLATION OF WELDED PIPING

- A. CONTRACTOR Qualification:
 - 1. CONTRACTOR shall submit the welding procedure and the welder qualification per ASME - Boiler and Pressure Vessel Code, Section IX, in order to perform welding in accordance with the ASME - Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping.
- B. Preparation:
 - 1. The edge of surface or part to be joined by welding shall be prepared by flame cutting or machining and shall be cleaned of oil or grease and excessive amount of scale, rust or other foreign material.
 - 2. The work area shall be kept clean at all times.
 - 3. Tie-ins to existing pipes shall be done after emptying the pipe and blowing the pipe with nitrogen.
 - 4. The following precautions must be followed when welding or torch cutting is required in area which contains flammable liquids processing equipment in services:
 - a. All open-ended lines and valves shall be blind flanged prior to commencing of the job.

- b. As much piping as practical shall be prefabricated.
 - c. Tie-ins to existing pipes shall be cold cut, stople and flange procedure.
 - 5. No welding allowed on materials to be joined when their temperature is below 40 degrees F. The material must be preheated to 65 degrees F.
- C. Welding Criteria:
 - 1. Carbon steel piping:
 - a. In sizes 1-1/2 inches and smaller, the welding shall be performed by means of the gas welding (oxyacetylene) process.
 - b. In sizes 2 inches and larger, the welding shall be performed by the metallic arc process with coated electrodes.
 - c. In sizes 1 inches and larger the welding may be done by wire welding process (gas metal arc welding).
 - 2. Stainless steel piping, type 304 SS or 316 SS.
 - a. The welding shall be done by gas tungsten arc welding process using a non-consumable electrode of thoriated tungsten.
 - b. Filler metal shall be 316 ELC (extra low carbon).
 - c. Shielding gas and internal purge gas shall be welding grade argon.
 - d. Post weld heat treatment: Annealed min. 1925 degrees F and rapidly cooled if corrosion resistance is required.
- D. Weld Quality and Repairs:
 - 1. 100 percent penetration is required on the entire length of the welded joints. Welds shall be free of defects, (undercoating, lack of penetration, cracks, etc.) Inside and outside of welds shall be smooth as possible. Add filler rod as necessary. The outside of all welds shall be cleaned by brushing.
 - 2. All welds should be made with one pass.
 - 3. Contractor shall be responsible for any defective welds, including the labor costs to repair or replace the defective weld and the cost of the x-ray of any such welds, until the welds pass inspection.
 - 4. Weld repairs failing three attempts shall be cut out and replaced with new spool piece at Contractor's expense. Quality procedures shall then apply as new weld.

3.3 FLASHING

- A. Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 12 inch minimum above finished roof surface with galvanized steel or aluminum flashing and neoprene boots. Flashing to match equipment materials. For pipes through outside walls turn flange back into wall and caulk.

- B. Secure all flashing w/ S.S. hardware.

3.4 SLEEVES

- A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
- B. Install seals and provide floor plate.
- C. Where piping or ductwork passes through floor, ceiling or wall where no potential moisture exists, close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.
- D. Install chrome plated escutcheons where piping passes through finished surfaces.

3.5 VALVES

- A. General:
 - 1. Provide valves of same manufacturer throughout where possible.
 - 2. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
 - 3. Install valves with stems upright or horizontal, not inverted.
 - 4. Install ball valves for shut-off and isolating service, to isolate equipment, part of systems or vertical risers.

3.6 EXPANSION COMPENSATION

- A. Installation:
 - 1. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation.
 - 2. Accomplish structural work and provide equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide corrugated bellows type expansion joints where required.
 - 3. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.
 - 4. Rigidly anchor pipe to building structure where necessary. Provide guides so that movement takes place along axis of pipe only.
 - 5. Install flexible connections on the suction and discharge lines of each pump, except in-line booster pumps, unless noted otherwise.

3.7 TESTING

- A. General:
 - 1. Test new systems only, from point of connection to the existing systems. Perform initial tests and correct deficiencies prior to requesting acceptance test.

2. Perform acceptance pressure tests in the presence of the Owner and authorities having jurisdiction. Acceptance test must be satisfactorily completed before piping surfaces are concealed.
3. Pneumatic tests shall be conducted using dry, oil free compressed air, carbon dioxide or nitrogen. Evacuate personnel not directly involved in testing prior to performing pneumatic testing. Perform testing in two stages, initial and acceptance. Conduct initial testing at 5 psi or less. Swab joints with a commercial leak detector. Repair deficiencies prior to testing at higher pressure.
4. Components shall be removed or isolated during testing if damage may occur due to test pressure and/or test media.
5. Provide pumps, gauges, instruments, test equipment personnel and clean auxiliary water. After tests have been made, remove all test equipment and drain all pipes.
6. Submit a complete test report to the Owner.
7. Operate pumps which have mechanical seal only with water in the system.
8. Test prior to painting, installation and insulation, or concealment.
9. Tests may be made on sections of piping as installed.
10. Re-test repaired or revised piping.

B. Pressure Systems:

1. Test pressure: 150 percent of the operating pressure or at test pressure in table below, whichever is greater.
2. Other requirements.

System	Test Media	Test Pressure	Permissible Pressure Drop
Underground Potable Water	Water	150 psig	0 psig in 4 hours
Above Ground Water	Water	150 psig	1 psig in 2 hours

C. Gravity System

1. Waste, drain, and vet systems, downspouts, rain leaders and their branches.
2. Entire System: Close all openings except the highest and fill system with water to point of overflow.
3. Sections: Close all opening, except highest, and provide a head of 10 feet. In testing successive sections, at least the upper 10 feet of next preceding section shall be included so that every joint and pipe in the whole system (except the uppermost 10 feet) shall have been subjected to a head of 10 feet of water.

4. After system or section under test has been filled with water, wait at least 15 minutes before starting inspection.
5. After 2 hours (minimum) there shall be no evidence of leakage.
6. Test waste, drain and vent pipe system before fixtures are installed and retest after fixtures have been installed.

3.8 LUBRICATION

- A. Ensure that all motors and equipment, as required, are properly lubricated before such items are accepted by the Owner.

3.9 CLEANING OF DOMESTIC PIPING SYSTEMS

- A. All work shall comply with AWWA, NSF and the City of Ann-Arbor Standards.
- B. Domestic water: Flush with chlorine solution-AWWA C6-168 "Disinfecting Water Mains".
- C. Compressed Air and Natural Gas: Blow clear of chips and scale with 100 psig air.

3.10 PIPE AND EQUIPMENT IDENTIFICATION

- A. Pipe and equipment identification is specified in Section 15075, Mechanical Identification.

3.11 SPARE FILTERS

- A. Provide two years of spare filters for all equipments.
- B. Store filters in a location designated by the Owner.
- C. Label the filters to indicate the matching piece of equipments,

END OF SECTION

SECTION 15075

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Equipment Labels
 - 2. Warning Signs and Labels
 - 3. Pipe Labels
 - 4. Chillers
 - 5. Valves
 - 6. Variable Speed Drives
 - 7. Field Instruments

1.2 ACTION SUBMITTALS

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

PART 2 – PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Marking Services, Inc.
 - d. Seton Identification Products.
 - 2. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 3. Letter Color: Black.
 - 4. Background Color: White.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Marking Services, Inc.
 - d. Seton Identification Products.
 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 3. Letter Color: Black.
 4. Background Color: White.
 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel rivets.
 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification

Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Seton Identification Products.
 - 4. Stranco, Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: White.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Marking Services Inc.
 - 4. Seton Identification Products.

- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

PART 3 – EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

3.3 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 1. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 2. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 3. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 4. Near major equipment items and other points of origination and termination.

5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
6. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Chilled-Water Piping: White letters on a safety-green background.
2. Condenser-Water Piping: White letters on a safety-green background.
3. Refrigerant Piping: White letters on a safety-purple background.

END OF SECTION

SECTION 15100

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Steel pipe and fittings.
 - 2. Plastic pipe and fittings.
 - 3. Joining materials.
 - 4. Transition fittings.
 - 5. Dielectric fittings.
 - 6. Bypass chemical feeder.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pipe.
 - 2. Fittings.
 - 3. Joining materials.
 - 4. Bypass chemical feeder.
- B. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
 - 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Chilled-Water Piping: 150 psig at 73 deg F.
 - 2. Condenser-Water Piping: 150 psig at 73 deg F.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
 - 1. Schedule 40 steel pipe; fittings; cast-iron flanges and flange fittings; and welded joints.
- C. Condenser-water piping, aboveground, NPS 2 and smaller, shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- D. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
 - 1. Schedule 40 steel pipe; fittings; cast-iron flanges and flange fittings; and welded joints.
- E. Plant Process Piping, located above ground in Ozone Building, shall be the following:
 - 1. Schedule 10 stainless steel; fittings; stainless steel flange and flange fittings; and welded joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to the following:
 - 1. Section 15112 "Globe Valves for HVAC Piping."
 - 2. Section 15113 "Butterfly Valves for HVAC Piping."
 - 3. Section 15114 "Check Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 Insert pipe size and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 15181 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- U. Comply with requirements in Section 15075 "Identification for HVAC Piping and Equipment" for identifying piping.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15441 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15441 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15181 "Escutcheons for HVAC Piping."
- Y. All piping will be pre-painted with factory coatings.

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 15116 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements in Section 15442 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
- D. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced code, and authorities having jurisdiction requirements, whichever are most stringent.

- G. Support horizontal piping within 12 inches of each fitting and coupling

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 15111 "Meters and Gages for HVAC Piping."

3.7 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum

yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 15101

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air-control devices.
2. Strainers.
3. Connectors.

B. Related Requirements:

1. Section 15113 "Butterfly Valves for HVAC Piping" for specification and installation requirements for butterfly valves common to most piping systems.
2. Section 15114 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. TACO Comfort Solutions, Inc.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

2.2 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

2.3 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install throttling-duty valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

END OF SECTION

SECTION 15102

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Refrigerant pipes and fittings.
 - 2. Refrigerant piping valves and specialties.
 - 3. Refrigerants.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant piping, and refrigerant piping specialty.
- B. Sustainable Design Submittals:
 - 1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
- C. Shop Drawings:
 - 1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 2. Show interface and spatial relationships between piping and equipment.
 - 3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Hot-Gas and Liquid Lines: 535 psig.
- B. Line Test Pressure for Refrigerant R-134A:
 - 1. Hot-Gas and Liquid Lines: 225 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L. or ASTM B280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.
- G. Copper Pressure-Seal Fitting for Refrigerant Piping:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Conex Banninger.
 - b. Parker Hannifin, Sporlan Division.
 - 2. Housing: Copper
 - 3. O-Rings: HNBR or compatible with specific refrigerant.
 - 4. Tools: Manufacturer's approved special tools.
 - 5. Minimum Rated Pressure: 700 psig

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Danfoss Inc.
 - c. Emerson Climate Technologies.
 - d. Heldon Products; Henry Technologies.
 - e. Parker Hannifin Corp.
 - f. Paul Mueller Company.

2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
 - f. Refrigeration Sales, Inc.
2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
2. Body and Bonnet: Plated steel.
3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil.
7. Working Pressure Rating: 400 psig.
8. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
 2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 3. Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Seat: Polytetrafluoroethylene.
 5. End Connections: Threaded.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. _or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 42°F.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig Insert value.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker Hannifin Corp.
 2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 6. Seat: Polytetrafluoroethylene.
 7. Equalizer: Internal.
 8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 115-V ac coil.
 9. End Connections: Socket.
 10. Throttling Range: Maximum 5 psig.
 11. Working Pressure Rating: 500 psig.
 12. Maximum Operating Temperature: 240 deg F.
- I. **Straight-Type Strainers:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker Hannifin Corp.
2. Body: Forged brass or cast bronze.
3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color coded to show moisture content in parts per million (ppm).
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

- L. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina or charcoal.
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 40 tons).
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

2.4 REFRIGERANTS

- A. ASHRAE 34, R-134A: Tetrafluoroethane
R-410A: Pentafluoroethane/Difluoromethane.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.
 - d. Mexichem Fluor Inc.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134A / R-410A

- A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Section 15950 "Sequence of Operations for HVAC DDC" for sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Section 15075 "Identification for HVAC Piping and Equipment."

- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15441 "Sleeves and Sleeve Seals for HVAC Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15441 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15181 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic restraints in Section 15116 "Vibration and Seismic Controls for HVAC."
- B. Comply with Section 15442 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install the following pipe attachments:
 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches of each fitting.
- F. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

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

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 15111

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Liquid-in-glass thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gages.
 - 5. Gage attachments.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ashcroft Inc.
 - 2. Blue Ribbon Corp.
 - 3. Ernst Flow Industries.
 - 4. Marsh Bellofram.
 - 5. Miljoco Corporation.
 - 6. Nanmac Corporation.
 - 7. Noshok.
 - 8. Palmer Wahl Instrumentation Group.
 - 9. REOTEMP Instrument Corporation.
 - 10. Tel-Tru Manufacturing Company.
 - 11. Trerice, H. O. Co.
 - 12. WATTS.

- 13. Weiss Instruments, Inc.
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle and rigid, bottom, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Blue Ribbon Corp.
 - b. Flo Fab Inc.
 - c. Miljoco Corporation
 - d. Palmer Wahl Instrumentation Group
 - e. Tel-Tru Manufacturing Company
 - f. Trerice, H. O. Co.
 - g. Weiss Instruments, Inc.
 - h. Weksler Glass Thermometer Corp.
 - i. Winters Instruments - U.S.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum Insert material; 7-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle Back angle Straight unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red] organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.

7. Window: Glass or plastic
8. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.4 DIAL-TYPE PRESSURE GAGES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Blue Ribbon Corp.
 - d. Ernst Flow Industries.
 - e. Flo Fab Inc.
 - f. Marsh Bellofram.
 - g. Miljoco Corporation.
 - h. Noshok.
 - i. Palmer Wahl Instrumentation Group.
 - j. REOTEMP Instrument Corporation.
 - k. Tel-Tru Manufacturing Company.
 - l. Trerice, H. O. Co.
 - m. WATTS.
 - n. Weiss Instruments, Inc.

2. Standard: ASME B40.100.
3. Case: Sealed Solid-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

- G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- H. Install valve and syphon fitting in piping for each pressure gage for steam.
- I. Install test plugs in piping tees.
- J. Install flow indicators in piping systems in accessible positions for easy viewing.
- K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- L. Install flowmeter elements in accessible positions in piping systems.
- M. Install wafer-orifice flowmeter elements between pipe flanges.
- N. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- O. Install permanent indicators on walls or brackets in accessible and readable positions.
- P. Install connection fittings in accessible locations for attachment to portable indicators.
- Q. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- R. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Two inlets and two outlets of each chiller.
 - 3. Two inlets and two outlets of each hydronic heat exchanger.
 - 4. Inlet and outlet of each thermal-storage tank.
- S. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water connection.
 - 3. Suction and discharge of each pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.

- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi.

END OF SECTION

SECTION 15112

GLOBE VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze globe valves.
 - 2. Iron globe valves.
 - 3. Chainwheels.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder-joint connections.
 - 5. ASME B31.1 for power piping valves.
 - 6. ASME B31.9 for building services piping valves.
- C. Refer to HVAC valve schedule articles for applications of valves.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 BRONZE GLOBE VALVES

- A. Bronze Globe Valves, Class 125:

- B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.
 - 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 - 2. Chain: Hot-dip-galvanized steel, of size required to fit sprocket rim.

2.5 FLOW CONTROL VALVE

- A. Valves shall be ductile iron globe style valve with ANSI B16.42 Class 150# flanges rated to 250 psi maximum working pressure. Valve shall allow flow control of downstream. Valve will be fully open or fully closed.

Valve design shall be single chamber, diaphragm actuated, pilot operated full port globe valves. Valve shall be factory lined and coated with NSF-61 approved fusion bonded epoxy with a 8-10 mils average DFT. Valve trim (stem and seat) and all inside and outside hardware including nuts, bolts and washers shall be 316 stainless steel. Diaphragm, resilient disc and seals shall be EPDM.

- 1. Flow control valve shall have solenoid with valve normally open and solenoid energized to close the main valve; solenoid shall allow for remote control override capability with 120 Volt solenoids.
- 2. Provide valves with valve position transmitter, 24VDC IP, calibrated 4-20mA OP for 0-100% of valve travel.

- 2.6 Valves shall be Singer Model 3" Stainless Steel 106-SC-NO-AC

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches Insert dimension above finished floor.

3.2 ADJUSTING

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

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Throttling Service except Steam: Globe valves.
 - 2. Throttling Service, Steam: Globe valves.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze globe valves, Class 125, with bronze disc, and with soldered ends.
- B. Pipe NPS 2-1/2 and Larger: Iron globe valves, Class 125, with flanged ends.

END OF SECTION

SECTION 15113

BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Iron, single-flange butterfly valves.
 - 2. Chainwheels.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.1 for flanges on iron valves.
 - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 3. ASME B31.1 for power piping valves.
 - 4. ASME B31.9 for building services piping valves.
- C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. Valve Actuator Types:
 - 1. Gear Actuator: For valves NPS 8 and larger.
 - 2. Handlever: For valves NPS 6 and smaller.
 - 3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.
- F. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. DeZURIK.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.

2.3 CHAINWHEELS

- ### A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Babbitt Steam Specialty Co.
 2. Roto Hammer Industries.
 3. Trumbull Industries.
- ### B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.
1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.

- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

3.2 ADJUSTING

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

3.3 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2-1/2 and Larger:
 - 1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.

END OF SECTION

SECTION 15114

CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze lift check valves.
 - 2. Bronze swing check valves.
 - 3. Iron swing check valves.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder joint.
 - 5. ASME B31.1 for power piping valves.
 - 6. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions.
 - c. Milwaukee Valve Company.
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.3 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions.
 - c. Milwaukee Valve Company.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.

2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:

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

- a. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and spring.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 ADJUSTING

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

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring; metal or resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and spring closure control, Class 125.
3. Iron swing check valves with metal seats, Class 125.

3.5 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and spring-closure control, Class 125.
3. Iron swing check valves with metal seats, Class 125.

END OF SECTION

SECTION 15115

INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Liquid and steam temperature sensors.
 - 2. Thermal Dispersion Flow Meter

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Environmental Conditions:
 - 1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated[**and cooled**], filtered, and ventilated as required by instrument and application.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:

- 1) Chiller and Boiler Rooms: Type 12.

2.2 LIQUID AND STEAM TEMPERATURE SENSORS, COMMERCIAL GRADE

A. RTD:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. MAMAC Systems, Inc.
2. Description:
 - a. Platinum with a value of 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
 - b. Encase RTD in a stainless-steel sheath with a 0.25-inch OD.
 - c. Sensor Length: 4, 6, or 8 inches as required by application.
 - d. Process Connection: Threaded, NPS 1/2
 - e. Two-stranded copper lead wires.
 - f. Powder-coated steel enclosure, NEMA 250, Type 4.
 - g. Conduit Connection: 1/2-inch
 - h. Performance Characteristics:
 - 1) Range: Minus 40 to 210 deg F.
 - 2) Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.

B. Thermowells:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. MAMAC Systems, Inc.
2. Stem: Straight or stepped shank formed from solid bar stock.
3. Material: Brass or stainless steel.
4. Process Connection: Threaded, NPS 3/4.
5. Sensor Connection: Threaded, NPS 1/2.
6. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
7. Furnish thermowells installed in insulated pipes and equipment with an extended neck.
8. Length: 4, 6, or 8 inches as required by application.
9. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

2.3 THERMAL DISPERSION FLOW METER – WATER/LIQUID APPLICATIONS

- A. 3” - hygienic with stainless steel construction
- B. Hot tap insertion style with factory isolation valving for in-place removal and inspections
- C. NSF approved.
- D. 4-20mA Hart analog output
- E. 24V DC power, supply power supply as required, max draw 225mA
- F. Thermal mass measuring principle with integrated thermal heater and reference thermal couples
- G. Standard NPT connections
- H. Measuring range 373 gallons per hours to 37,300 gallons per hours, accuracy with 2% across complete flow range.
- I. 3” Integrated and seal factory display for calibration and monitoring
- J. 1-year warranty after commissioning.
- K. Approved manufacturers, Endress & Hauser Proline t-mass T150 Hygienic or ENGINEER approved equal.

PART 3 - EXECUTION

3.1 TEMPERATURE INSTRUMENT APPLICATIONS

- A. Liquid and Steam Temperature Sensors:
 - 1. Chilled Water System,: Liquid and steam temperature sensor, commercial grade.

3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- C. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.6 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.7 CHECK-OUT PROCEDURES

- A. Check installed products before continuity tests, leak tests, and calibration.
- B. Check temperature instruments for proper location and accessibility.
- C. Verify sensing element type and proper material.
- D. Verify location and length.
- E. Verify that wiring is correct and secure.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Perform according to manufacturer's written instruction.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

END OF SECTION

SECTION 15116

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Restrained-spring isolators.
 - 6. Pipe-riser resilient supports.
 - 7. Resilient pipe guides.
 - 8. Elastomeric hangers.
 - 9. Spring hangers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each vibration isolation device.
 - 1. Include design calculations for selecting vibration isolators.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads: .
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Novia; A Division of C&P.
 - g. Vibration Eliminator Co., Inc.
 - h. Vibration Isolation.
 - i. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Ribbed or Waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.

2.2 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Novia; A Division of C&P.
 - g. Vibration Eliminator Co., Inc.
 - h. Vibration Isolation.
 - i. Vibration Mountings & Controls, Inc.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.3 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.

- f. Novia; A Division of C&P.
 - g. Vibration Eliminator Co., Inc.
 - h. Vibration Isolation.
 - i. Vibration Mountings & Controls, Inc.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with elastomeric pad.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.4 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psigon isolation material providing equal isolation in all directions.

2.5 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.6 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.

- c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Novia; A Division of C&P.
 - g. Vibration Eliminator Co., Inc.
 - h. Vibration Mountings & Controls, Inc.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.7 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 - e. Novia; A Division of C&P.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points with existing concrete.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION

SECTION 15117

PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Liquid-pressure switches.
 - 2. Liquid-pressure transmitters.
- B. Related Requirements:
 - 1. Integrate new devices into existing DDC system. Provide firmware and software as required to integrate new to existing devices.
 - 2. Section 15950 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 15117.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 LIQUID-PRESSURE SWITCHES

- A. Liquid Gage Pressure Switch, Diaphragm Operated, Low Pressure:

WTP OZONE DISINFECTION CHILLER REPLACEMENT

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Mercoïd Controls: Dwyer Instruments, Inc.

2. Description:
 - a. Diaphragm operated to actuate an SPDT snap switch.
 - b. Electrical Connections: Screw terminal.
 - c. Enclosure Conduit Connection: Knock out or threaded connection.
 - d. User Interface: External screw with visual set-point adjustment.
 - e. Process Connection: Threaded, NPS 1/4.
 - f. Enclosure:
 - 1) Dry Indoor Installations: NEMA 250, Type 1.
 - 2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
 - 3) Hazardous Environments: Explosion proof.

3. Operating Data:
 - a. Electrical Rating: 15 A at 120-V ac.
 - b. Pressure Limits:
 - 1) Range 1 to 30 psig: 60 psig.
 - c. Temperature Limits: Minus 30 to 150 deg F.
 - d. Operating Range: 10 to 250 psig.
 - e. Deadband: Fixed.

4. Pressure Chamber Material: Steel or Stainless steel.
5. Diaphragm Material: Nylon or PTFE.

B. Liquid-Pressure Differential Switch with Set-Point Indicator:

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

2. Description:
 - a. Brass or Type 316 stainless steel double opposing bellows operate to actuate a SPDT snap switch.
 - b. Electrical Connections: Screw terminal.
 - c. Enclosure Conduit Connection: Knock out or threaded connection.
 - d. User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
 - e. High and Low Process Connections: Threaded, NPS 1/8.
 - f. Enclosure:

- 1) Dry Indoor Installations: NEMA 250, Type 1.
- 2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
- 3) Hazardous Environments: Explosion proof.

g. Operating Data:

- 1) Electrical Rating: 15 A at 120- to 240-V ac.
- 2) Pressure Limits: At least 5 times full-scale range, but not less than system design pressure rating.
- 3) Temperature Limits: Minus 10 to 180 deg F.
- 4) Operating Range: Approximately 2 times set point.
- 5) Deadband: Adjustable or fixed as required by application.

2.2 LIQUID-PRESSURE TRANSMITTERS

A. Liquid-Pressure Differential Transmitter:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dwyer Instruments, Inc.
2. Performance:
 - a. Range: Approximately 2 times set point.
 - b. Span: Adjustable plus or minus one milliamp, noninteractive.
 - c. Accuracy: Within 0.25 percent of full scale.
 - d. Pressure: Maximum operating pressure 2.5 times range.
 - e. Temperature Limits: Zero to 175 deg F.
 - f. Compensate Temperature Limits: 30 to 150 deg F.
 - g. Thermal Effects: 0.02 percent of full scale per degree F.
 - h. Response Time: 30 to 50 ms.
 - i. Shock and vibration shall not harm the transmitter.
3. Analog Output Current Signal:
 - a. Two-wire, 4- to 20-mA dc current source.
 - b. Signal capable of operating into 1000-ohm load.
4. Operator Interface:
 - a. Zero and span adjustments located behind cover.
 - b. Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.
5. Construction:
 - a. Aluminum and stainless-steel enclosure with removable cover.
 - b. Wetted parts of transmitter constructed of 17-4 PH or 300 Series stainless steel.
 - c. Threaded, NPS 1/4 process connections on side of instrument enclosure.
 - d. Knock out for 1/2-inch nominal conduit connection on side of instrument enclosure.

- e. Screw terminal block for wire connections.
- f. NEMA 250, Type 4X.
- g. Mounting Bracket: Appropriate for installation.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a force.
- C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- F. Corrosive Environments:
 - 1. Use products that are suitable for environment to which they are subjected.
 - 2. If possible, avoid or limit use of materials in corrosive environments.
 - 3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
 - 4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.2 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.3 PRESSURE INSTRUMENT INSTALLATION

- A. Mounting Location:
 - 1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
 - 2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
 - 3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 - 4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 - 5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
 - 6. Install instruments (except pressure gages) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
 - 7. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.
- B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- C. Liquid-Pressure Differential Switches:
 - 1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
 - 2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
 - 3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
 - 4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2. Install stainless-steel bushing if required to mate switch to system connection.
 - 5. Connect process tubing from point of system connection and extend to switch.
 - 6. Install isolation valves in process tubing as close to system connection as practical.
 - 7. Install dirt leg and drain valve at each switch connection.
 - 8. Do not mount switches on rotating equipment.

9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

D. Liquid-Pressure Transmitters:

1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2. Install stainless-steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

3.5 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 15181

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Dearborn Brass.
 - 3. Jones Stephens Corp.
 - 4. Keeney Manufacturing Company (The).
 - 5. Mid-America Fittings, Inc.
 - 6. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece deep pattern.
 - b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping to Remain:
 - a. Chrome-Plated Piping: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

Subparagraphs below apply to both bare and insulated piping.

- 1. New Piping **[and]** Relocated Existing Piping: Split floor plate.
- 2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 15181

SECTION 15201

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of pump.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Aurora Pump; Pentair Ltd.
 - 3. Flowserve Corporation.
 - 4. PACO Pumps; Grundfos Pumps Corporation, USA.
 - 5. Peerless Pump Company.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 3. Pump Shaft: Stainless steel.
 4. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
 5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, secured to mounting frame, with adjustable alignment.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 15801 "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure: Totally enclosed, air over.
 - b. Enclosure Materials: Rolled steel.
 - c. Motor Bearings: Grease-lubricated ball bearings.
 - d. Efficiency: Premium efficient.
 - e. NEMA Design: B.
 - f. Service Factor: 1.15

2.2 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser:
1. Angle pattern.
 2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
 3. Bronze startup and bronze or stainless-steel permanent strainers.
 4. Bronze or stainless-steel straightening vanes.
 5. Drain plug.
 6. Factory-fabricated support.
- B. Triple-Duty Valve:
1. Angle or straight pattern.
 2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.

3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- E. Equipment Mounting:
 1. Install base-mounted pumps on existing cast-in-place concrete equipment base(s).
 2. Comply with requirements for vibration isolation devices specified in Section 15116 "Vibration Controls for HVAC."

3.2 ALIGNMENT

- A. Perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install triple-duty valve on discharge side of pumps.

SECTION 15250

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Chilled-water and brine piping, indoors and outdoors.
 - 2. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
 - 1. Section 15250 "HVAC Equipment Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Pittsburgh Corning Corporation.
 2. Block Insulation: ASTM C552, Type I.
 3. Special-Shaped Insulation: ASTM C552, Type III.
 4. Board Insulation: ASTM C552, Type IV.
 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C552, Type II, Class 1.
 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C552, Type II, Class 2.
 7. Factory fabricate shapes according to ASTM C450 and ASTM C585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. K-Flex USA.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dow Corning Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.

2.3 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 5. Color: White.

2.4 SEALANTS

- A. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 100 to plus 300 deg F.
 5. Color: White or gray.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Airex Manufacturing.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ideal Tape Co., Inc., an American Biltrite Company.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.

2.8 SECUREMENTS

- A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.

- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. C & F Wire.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Chilled Water and Brine, above 40 Deg F: Insulation shall be one of the following:
 - 1. Cellular Glass: 1-1/2 inches thick.
 - 2. Flexible Elastomeric: 1-1/2 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric 1 inch, thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Insulation shall be the following:
 - 1. Flexible Elastomeric: 2 inches thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be the following:
 - 1. Flexible Elastomeric: 2 inches thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
 - 1. PVC: 20 mils thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. PVC: 30 mils thick.

END OF SECTION

SECTION 15441

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves
 - 2. Sleeve-Seal Systems
 - 3. Grout
 - 4. Silicone Sealants

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated or zinc coated, with plain ends and integral welded waterstop collar.
- D. Galvanized-Steel Sheet Pipe Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- E. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
 2. Airex Manufacturing.
 3. CALPICO, Inc.
 4. GPT; an EnPro Industries company.
 5. Metraflex Company (The).
 6. Proco Products, Inc.
- B. Description:
1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 2. Designed to form a hydrostatic seal of 20-psig.
 3. Sealing Elements: EPDM-rubber and High-temperature-silicone interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 4. Pressure Plates: Carbon steel.
 5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Dow Corning Corporation.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. Pecora Corporation.
 - d. Polymeric Systems, Inc.
 - e. Schnee-Morehead, Inc., an ITW company.
 - f. Sherwin-Williams Company (The).
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. May National Associates, Inc.; a subsidiary of Sika Corporation.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space

between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6: Steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Steel-pipe sleeves.
 - 2. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs Above Grade:
 - a. Piping Smaller Than NPS 6: Steel-pipe sleeves.
 - 4. Interior Partitions:
 - a. Piping Smaller Than NPS 6.

END OF SECTION

SECTION 15442

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.

- B. Related Requirements:
 - 1. Section 15116 "Vibration Controls for HVAC" for vibration isolation devices.

1.2 ACTION SUBMITTALS

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

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Equipment supports.

- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01450 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
 - 3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe and Tube Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. National Pipe Hanger Corporation.
 - 2. Pipe Shields Inc.
 - 3. Piping Technology & Products, Inc.
 - 4. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi minimum compressive strength and vapor barrier.

- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

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

WTP OZONE DISINFECTION CHILLER REPLACEMENT

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

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

3.5 ADJUSTING

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

3.6 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

END OF SECTION

SECTION 15511

AIR-COOLED, SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.2 DEFINITIONS

- A. BAS: Building automation system.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. DDC: Direct digital control.
- D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.
- E. GFI: Ground fault interrupt.
- F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- G. I/O: Input/output.
- H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
- J. SCCR: Short-circuit current rating.
- K. TEAO: Totally enclosed air over.
- L. TENV: Totally enclosed nonventilating.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:

1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
 2. Product Data: For energy performance.
- C. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
1. Assembled unit dimensions.
 2. Weight and load distribution.
 3. Required clearances for maintenance and operation.
 4. Size and location of piping and wiring connections.
 5. Diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Certificates: For certification required in "Quality Assurance" Article.
- B. Seismic Qualification Data: Certificates, for water chillers, accessories, and components, from manufacturers.
- C. Installation instructions.
- D. Source quality-control reports.
- E. Startup service reports.
- F. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.
 1. Extended warranties include, but are not limited to, the following:
 - a. Complete chiller including refrigerant and oil charge.
 - 1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.
 - b. Parts and labor.

2. Based Warranty Period: Two years from date of Substantial Completion
Optional Warranty Period: Five years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- B. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
- C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- F. Comply with NFPA 70.
- G. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.
- H. Operation Following Loss of Normal Power:
 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
 2. See drawings for equipment served by backup power systems.
 3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. TraneAlternates:
 1. York / Johnson Controls
 2. Carrier Corporation / United Technologies Corp

3. Engineer Approved Equal.

2.3 MANUFACTURED UNITS

- A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.
- B. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

2.4 CABINET

- A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
- B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
- C. Casing: Galvanized steel.
- D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.

2.5 COMPRESSOR-DRIVE ASSEMBLIES

- A. Compressors:
 1. Description: Positive-displacement direct drive with hermetically sealed casing.
 2. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
 3. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
 - a. Digital compressor unloading is an acceptable alternative to achieve capacity control.
 4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
 - a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.
 5. Vibration Isolation: Mount individual compressors on vibration isolators.
 - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
- B. Compressor Motors:
 1. Hermetically sealed and cooled by refrigerant suction gas.
 2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

- C. Compressor Motor Controllers:
 - 1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

2.6 REFRIGERATION

- A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.
- B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- C. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
- D. Pressure Relief Device:
 - 1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
 - 3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.7 EVAPORATOR

- A. Brazed Plate:
 - 1. Direct-expansion, single-pass, brazed-plate design.
 - 2. Type 304 stainless-steel construction.
 - 3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
 - 4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. Furnish flange adapters to mate to flanged piping.
 - 5. Inlet Strainer: Factory-furnished, 20-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.
- B. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation.

2.8 AIR-COOLED CONDENSER

- A. Coil(s) with integral subcooling on each circuit.
- B. Aluminum Microchannel Coils:
 - 1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
 - 2. Single- or multiple-pass arrangement.
 - 3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

- C. Corrosion-Resistant Coating: Coat coils with an epoxy or a phenolic corrosion-resistant coating after fabrication.
- D. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
- E. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
- F. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
 - 1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.
- G. Fan Guards: Removable steel safety guards with corrosion-resistant PVC coating.

2.9 INSULATION

- A. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

2.10 ELECTRICAL

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
- C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
- D. Wiring shall be numbered and color-coded to match wiring diagram.
- E. Factory wiring shall be located outside of an enclosure in a metal raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.
- F. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 42,000 A.
- G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
 - 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - 2. NEMA KS 1, heavy-duty, nonfusible switch.
 - 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

- H. Each motor shall have overcurrent protection.
- I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
- J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
- K. Power Factor Correction: Capacitors to correct power factor to 0.95 at full load.
- L. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- M. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
- N. Service Receptacle:
 - 1. Unit-mounted, 120-V GFI duplex receptacle.
 - 2. Power receptacle from chiller internal electrical power wiring.
- O. Indicate the following for water chiller electrical power supply:
 - 1. Current, phase to phase, for all three phases.
 - 2. Voltage, phase to phase and phase to neutral for all three phases.
 - 3. Three-phase real power (kilowatts).
 - 4. Three-phase reactive power (kilovolt amperes reactive).
 - 5. Power factor.
 - 6. Running log of total power versus time (kilowatt hours).
 - 7. Fault log, with time and date of each.

2.11 CONTROLS

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
- C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
 - 1. Date and time.
 - 2. Operating or alarm status.
 - 3. Operating hours.
 - 4. Outside-air temperature if required for chilled-water reset.
 - 5. Temperature and pressure of operating set points.
 - 6. Chilled-water entering and leaving temperatures.
 - 7. Refrigerant pressures in evaporator and condenser.
 - 8. Saturation temperature in evaporator and condenser.
 - 9. No cooling load condition.
 - 10. Elapsed time meter (compressor run status).

11. Pump status.
12. Antirecycling timer status.
13. Percent of maximum motor amperage.
14. Current-limit set point.
15. Number of compressor starts.
16. Alarm history with retention of operational data before unit shutdown.
17. Superheat.

E. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Capacity control based on evaporator leaving-fluid temperature.
3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
4. Chilled-water entering and leaving temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
5. Current limit and demand limit.
6. Condenser-water temperature.
7. External water chiller emergency stop.
8. Antirecycling timer.
9. Automatic lead-lag switching.
10. Ice-building mode.

F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

1. Low evaporator pressure or high condenser pressure.
2. Low chilled-water temperature.
3. Refrigerant high pressure.
4. High or low oil pressure.
5. High oil temperature.
6. Loss of chilled-water flow.
7. Loss of condenser-water flow.
8. Control device failure.

G. BAS System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.

1. Hardwired I/O Points:
 - a. Monitoring: On/off status, common trouble alarm electrical power demand (kilowatts) electrical power consumption (kilowatt hours) .
 - b. Control: On/off operation, chilled-water discharge temperature set-point adjustment.
2. Interface: Industry-accepted open-protocol communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight or flexible metallic conduit.

2.12 ACCESSORIES

- A. Factory-furnished spring isolators for field installation.
 - 1. Spring Deflection: 1 inch.

2.13 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to AHRI 550/590.
 - 1. Test the following conditions:
 - a. Design conditions indicated.
 - b. AHRI 550/590 part-load points.
 - 2. Allow Owner access to place where water chillers are being tested. Notify Owner 30 days in advance of testing.
- C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

PART 3 - EXECUTION

3.1 WATER CHILLER INSTALLATION

- A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.
- C. Install water chillers on support structure indicated.
- D. Equipment Mounting:
 - 1. Install water chillers on existing equipment bases.
 - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 15116 "Vibration Controls for HVAC."
 - 3. Comply with requirements for vibration isolation devices specified in Section 15116 "Vibration Controls for HVAC."
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. Maintain clearances required by governing code.
- G. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.2 PIPING CONNECTIONS

- A. Comply with requirements in Section 15100 "Hydronic Piping" and Section 15101 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 15102 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Where installing piping adjacent to chillers, allow space for service and maintenance.
- D. Connect each drain connection with a drain valve, full size of drain connection. Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.
- E. Connect each chiller vent connection with an automatic or a manual vent, full size of vent connection.

3.3 ELECTRICAL POWER CONNECTIONS

- A. Connect wiring according to Section 16121 "Low-Voltage Copper Wire and Cable."
- B. Ground equipment according to Section 16450 "Grounding"
- C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.4 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.
- C. Connect control wiring between chiller control interface and BAS System for remote monitoring and control of chillers.
- D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.
 - 3. Verify that thermometers and gages are installed.
 - 4. Operate water chiller for run-in period.
 - 5. Check bearing lubrication and oil levels.
 - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
 - 7. Verify proper motor rotation.
 - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
 - 9. Verify and record performance of chilled-water flow and low-temperature interlocks.
 - 10. Verify and record performance of water chiller protection devices.
 - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.
- E. Prepare a written startup report that records results of tests and inspections.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Video record the training sessions and provide electronic copy to Owner.
 - 1. Instructor shall be factory trained and certified.
 - 2. Provide not less than eight hours of training.
 - 3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
 - 4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 5. Obtain Owner sign-off that training is complete.
 - 6. Owner training shall be held at Project site.

END OF SECTION

SECTION 15512

AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged, air-cooled refrigerant condensers for outdoor installation.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
 - 2. Product Data: For energy performance.
- C. Shop Drawings: For air-cooled refrigerant condensers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

WTP OZONE DISINFECTION CHILLER REPLACEMENT

1. Trane

Alternates:

1. York / Johnson Controls
2. Carrier Corporation / United Technologies Corp
3. Engineer Approved Equal.

2.2 MANUFACTURED UNITS

- A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
- B. Refrigerant: R-410A.
- C. Condenser Coil: Factory tested at 650 psig.
 1. Coils shall be aluminum microchannel coils.
 2. Coating, Manufacturers' recommended coating to withstand ASTM B117 Salt Spray test for 1000 hrs.
 3. Circuit: To match compressors.
- D. Condenser Fans and Drives: Propeller fans with aluminum or galvanized-steel fan blades, for vertical air discharge; directly driven with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.
 1. Weather-proof motors with rain shield and shaft slinger.
 2. Extend grease lines to outside of casing.
- E. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 115-V control transformer, if required; magnetic contactors for condenser fan motors and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
 1. Fan Cycling Control: Head pressure switches.
- F. Casings: Galvanized or zinc-coated steel treated and finished with manufacturer's standard paint coating, designed for outdoor installation with weather protection for components and controls, and with the following:
 1. Removable panels for access to controls, condenser fans, motors, and drives.
 2. Plated-steel fan guards.
 3. Lifting eyes.
 4. Removable legs, 20 inches high.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 1. Enclosure Type: Totally enclosed, fan cooled.

2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Mount unit-mounted disconnect switches on exterior of unit.

2.4 SOURCE QUALITY CONTROL

- A. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Equipment Mounting:
 1. Install air-cooled condenser refrigerant condensers on existing cast-in-place concrete equipment bases.
 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.2 CONNECTIONS

- A. Install piping adjacent to machine to allow service and maintenance.
- B. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 15102 "Refrigerant Piping."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Perform electrical test and visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Verify proper airflow over coils.

- C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- D. Air-cooled refrigerant condensers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 15513

WATER-COOLED, ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged, water-cooled, multiple-compressor chillers.

1.2 DEFINITIONS

- A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- B. DDC: Direct digital control.
- C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- E. kVAR: Kilovolt amperes reactive.
- F. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- G. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than AHRI standard rating conditions.
- H. RTD: Resistance temperature detector.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For refrigerants, indicating compliance with refrigerant management practices.
 - 2. Product Data: For energy performance.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.

- E. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.
 - 1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
 - 2. Operating Range: From 100 to 20 percent of design capacity.
 - 3. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design, entering condenser-fluid temperature.

- F. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
 - 1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
 - 2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
 - 3. Factory-installed and pressure-tested piping with isolation valves and accessories.
 - 4. Oil compatible with refrigerant and chiller components.
 - 5. Positive visual indication of oil level.

- G. Vibration Control:
 - 1. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
 - a. Overspeed Test: 25 percent above design operating speed.
 - 2. Isolation: Mount individual compressors on vibration isolators.

- H. Compressor Motors:
 - 1. Hermetically sealed and cooled by refrigerant suction gas.
 - 2. High-torque, induction type with inherent thermal-overload protection on each phase.

- I. Refrigerant Circuits:
 - 1. Refrigerant Type: R-134a. Classified as Safety Group A1 according to ASHRAE 34.
 - 2. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
 - 3. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
 - 4. Pressure Relief Device:
 - a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

- J. Evaporator:
 - 1. Description: Shell-and-tube design.
 - a. Direct-expansion type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.

- b. Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.
 - 2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 3. Shell Material: Carbon steel.
 - 4. Shell Heads: Removable carbon-steel heads with multipass baffles, and located at each end of the tube bundle.
 - 5. Fluid Nozzles: Terminated with mechanical-coupling or flanged end connections for connection to field piping.
 - 6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
- K. Condenser:
 - 1. Shell and Tube:
 - a. Description: Shell-and-tube design with refrigerant flowing through shell, and fluid flowing through tubes within shell.
 - b. Provides positive subcooling of liquid refrigerant.
 - c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - d. Shell Material: Carbon steel.
 - e. Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.
 - f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
 - g. Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.
- L. Electrical Power:
 - 1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.
 - 2. House in a unit-mounted, NEMA 250, Type 4 enclosure with hinged access door.
 - 3. Wiring shall be numbered and color-coded to match wiring diagram.
 - 4. Field-power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
 - a. Disconnect means shall be interlocked with door operation.
 - b. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 A.
 - 5. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
 - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - b. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
 - 6. Provide each motor with overcurrent protection.
 - 7. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
 - 8. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.

- a. Manual or automatic startup and shutdown time schedule.
 - b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water temperature.
 - c. Current limit and demand limit.
 - d. Condenser-fluid temperature.
 - e. External chiller emergency stop.
 - f. Antirecycling timer.
 - g. Automatic lead-lag switching.
 - h. Variable evaporator flow.
 - i. Thermal storage.
5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
- a. Low evaporator pressure or high condenser pressure.
 - b. Low chilled-water temperature.
 - c. Refrigerant high pressure.
 - d. High or low oil pressure.
 - e. High oil temperature.
 - f. Loss of chilled-water flow.
 - g. Loss of condenser-fluid flow.
 - h. Control device failure.
6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
9. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display chiller status and alarms.
- a. Industry-accepted, open-protocol communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the DDC system for HVAC.
- O. Insulation: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- P. Finish: Paint chiller, using manufacturer's standard procedures.
- Q. Accessories:
- 1. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
 - 2. Factory-furnished neoprene or spring isolators for field installation.

2.3 SOURCE QUALITY CONTROL

- A. Perform functional tests of chillers before shipping.

- B. Factory performance test water-cooled chillers, before shipping, according to AHRI 550/590.
 - 1. Test the following conditions:
 - a. At four point(s) of varying part-load performance to be selected by Owner at time of test.
 - 2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- C. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. For chillers located indoors, rate sound power level according to AHRI 575.

PART 3 - EXECUTION

3.1 CHILLER INSTALLATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- D. Install chillers on support structure indicated.
- E. Equipment Mounting:
 - 1. Install chillers on existing cast-in-place concrete equipment bases.
- F. Maintain manufacturer's recommended clearances for service and maintenance.
- G. Charge chiller with refrigerant and fill with oil if not factory installed.
- H. Install separate devices furnished by manufacturer and not factory installed.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 15100 "Hydronic Piping," Section 15101 "Hydronic Piping Specialties," Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange.

SECTION 15801

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation:**Class F**.
- I. Code Letter Designation:
 - 1. Motors **15HP** and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than **15 HP**: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes **324T** and larger; rolled steel for motor frame sizes smaller than **324T**.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers:**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

WTP OZONE DISINFECTION CHILLER REPLACEMENT

- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 15950

SEQUENCE OF OPERATIONS FOR HVAC DDC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes control sequences for DDC for HVAC systems, subsystems, and equipment.
- B. Related Requirements:
 - 1. Existing "DDC Systems for HVAC" for control equipment. Integrate new devices into existing DDC system. Provide firmware and software as required to integrate new to existing devices.

1.2 CENTRAL CHILLED-WATER SYSTEM SEQUENCES

- A. Central Chilled-Water System Occupied Time Schedule:
 - 1. Enable chillers startup, initiation, and control based on water flow.
 - 2. After chilled-water system shutdown, operate pump(s) for an additional 3 minutes time.
- B. Start and Stop Chilled Water Pump(s): Confirm outdoor-air temperature is above 50 deg F and energize pump(s).
- C. Alternate Chiller(s):
 - 1. Operate Alternate chiller(s) on manual changeover. Retain existing sequences as required.
 - 2. Start additional chiller when load exceeds capacity of operating chillers as follows:
 - a. When common chilled-water supply temperature exceeds set point for a 10-minute period.
 - b. When combination of outdoor temperature and time schedule ensure enough run-time before time schedule shutdown.
- D. Alarm Chiller(s) Start Failure: Signal alarm on signal from chillers control panel.
- E. Start and Stop Chiller(s): Report chillers electronic control, operating, and alarm functions.
- F. Chilled-Water Level: Signal alarm on low pressure.
- G. Chilled-Water Supply Temperature: Maintain chilled-water supply temperature.

The CONTRACTOR will fully document all lock out conditions as part the submittal review process include inhibit and reset timers.

1. Reset chilled-water supply temperature in straight-line relationship with temperature for the following conditions:

Reset chilled-water supply temperature based on constant return chilled-water temperature of 54 deg F.

- H. Control Circulating Pump(s) Speed:
 1. Control pump speed using VSD's to maintain minimum flow through primary and alternate chillers based on flow.
 2. Provide flow sensor(s) as defined in other sections.
 3. Report pressure drop and flow.
- I. Circulation through Chiller: Report pressure drop and flow through chillers.
- J. Indicate the following on the operator's workstation display terminal for both chillers:
 1. DDC system graphic.
 2. DDC system status, on-off.
 3. Outdoor temperature.
 4. Cooling (software) demand indication.
 5. Time and time schedule.
 6. Alternate water source pump(s) on-off status (enabled or disabled).
 7. Alternate water source pump(s) on-off indication (operating or not operating).
 8. Alternate water source flow indication.
 9. Chilled-water pump(s) on-off status (enabled or disabled).
 10. Chilled-water pump(s) on-off indication (operating or not operating).
 11. Chilled-water flow indication.
 12. Chilled-water pump differential pressure.
 13. Refrigeration machine on-off indication (operating or not operating).
 14. Chilled-water supply temperature.
 15. Chilled-water return temperature.
 16. Chilled-water temperature control-point adjustment.
 17. Chiller(s) on-off status (enabled or disabled).
 18. Chiller(s) on-off indication (operating or not operating).
 19. Chillers "failure-to-start" indication.
 20. Chiller(s) power input (instantaneous).
 21. Chilled-water pressure drop through chillers.
 22. Chilled-water flow through chillers.
 23. Chiller condenser-water supply and return temperature.
 24. Chiller chilled-water supply and return temperature.
 25. System capacity in tons.
 26. Low flow alert from thermal dispersion flow switch.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 15951

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:
 - 1. Cooling generation systems.
 - 2. Air, steam, and hydronic distribution systems.
 - 3. HVAC controls.
 - 4. TAB verification.
- B. Related Requirements:
 - 1. Section 01810 "Commissioning" for general Cx process requirements and CxA responsibilities.
 - 2. For construction checklists, comply with requirements in various Division 15 Sections specifying HVAC systems, system components, equipment, and products.

1.2 DEFINITIONS

- A. Cx: Commissioning, as defined in Section 01810 "Commissioning."
- B. CxA: Commissioning Authority, as defined in Section 01810 "Commissioning."
- C. DDC: Direct digital controls.
- D. HVAC: Heating, ventilating, and air conditioning.
- E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- F. TAB: Testing, adjusting, and balancing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLIST REVIEW

- A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.

- B. Return draft construction checklist review comments within 10 days of receipt.
- C. When review comments have been resolved, the CxA will provide final construction checklists, marked "Approved for Use, (date)."
- D. Use only construction checklists, marked "Approved for Use, (date)."

3.2 Cx TESTING PREPARATION

- A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved submittals.
- B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved submittals, and that pretest set points have been recorded.
- C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.3 Cx TEST CONDITIONS

- A. Perform tests using design conditions, whenever possible.
 - 1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
 - 2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
 - 3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
- C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 Cx TESTS COMMON TO HVAC SYSTEMS

- A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

- B. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.
- C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
- D. Comply with construction checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Division 15 Sections specifying HVAC systems and equipment.
- E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
 - 1. Construction checklist verification tests.
 - 2. Construction checklist verification test demonstrations.
 - 3. Cx tests.
 - 4. Cx test demonstrations.
- F. Vibration Isolation in HVAC Systems:
 - 1. Prerequisites: Acceptance of results of construction checklists for vibration control devices specified in Section 15116 "Vibration Controls for HVAC Piping and Equipment."
 - 2. Components to Be Tested:
 - a. Vibration isolation control devices in HVAC systems.
 - b. Structural systems.
 - 3. Test Purpose: Evaluate effectiveness of vibration isolation control devices.
 - 4. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness while the isolated equipment operates.
 - 5. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness at the following operating conditions:
 - a. Maximum speed.
 - b. Minimum speed.
 - c. Critical speed.
 - 6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

3.5 CENTRAL REFRIGERATION SYSTEM Cx TESTS

- A. Start and Stop Chilled-Water Pump(s):
 - 1. Prerequisites: Installation verification of the following:
 - a. Startup of chilled-water pump(s) P-1, P-2.
 - b. Input Device: Flow switch in condenser-water circuit.
 - c. Output Device: Starter relay.
 - d. Display of the following at the operator's workstation:
 - 1) Chilled-water flow indication.
 - 2) Condenser-water flow indication.
 - 3) Chilled-water pump(s) on-off status.

- 4) Chilled-water pump(s) on-off indication.
2. Scope: Chilled-water system, including chilled-water pump(s), associated controls, and condenser-water system controls.
 3. Purpose:
 - a. Chilled-water pump(s) start.
 - b. Chilled-water pump(s) shutdown.
 4. Conditions of the Test:
 - a. Verify Start: Start with chilled-water pump enable-input device in the "disable" state to prevent pump start. Place the enable-input device in the "enable" state.
 - b. Verify Shutdown: Start with the enable-input device in the "enable" state to allow the pump(s) to run. Then place the enable-input device in the "disable" state.
 5. Acceptance Criteria:
 - a. Start: Chilled-water pump(s) start when, and only when, the enable-input device is in the "enable" state.
 - b. Shutdown: The enable-input device stops the chilled-water pump(s) when placed in the "disable" state.
- B. Alternative Chiller(s):
1. Prerequisites: Installation verification of the following:
 - a. Input Device: DDC system software.
 - b. Output Device: DDC system command to chiller terminal strip.
 - c. Display:
 - 1) Chiller(s) on-off indication.
 - 2) Chiller failure alarm.
 2. Scope:
 - a. Chilled-water system and associated controls.
 - b. Condenser-water system and associated controls.
 3. Purpose:
 - a. Lead-lag rotation of chillers.
 - b. Replacement of failed chiller in rotation.
 - c. Adding and dropping chillers as follows: .
 - d. Replacement of failed chiller in add/drop sequence.
 - e. Chiller failure alarm initiation.
 4. Conditions of the Test:
 - a. Add/Drop Sequence - Increasing Demand: Increase chilled-water demand incrementally to observe the corresponding addition of chillers. Increase demand gradually as the load approaches the set point for adding the next chiller, to permit observation of the actual load at the time the next chiller is enabled.

SECTION 16010

ELECTRICAL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work Included
- B. Codes and Standards
- C. Drawings
- D. Record Drawings
- E. Operation and Maintenance Manuals
- F. Site Examination
- G. Utilities
- H. Temporary Power
- I. Storage at Site
- J. Equipment and Materials
- K. Workmanship and Completion of Installation
- L. Cutting and Patching
- M. Coordination
- N. HVAC Equipment Wiring and Control
- O. Miscellaneous

1.2 RELATED SECTIONS

- A. The requirements set out in the contract documents, contract forms, general conditions, supplementary general conditions and general requirements apply to all work specified herein.

1.3 WORK INCLUDED

- A. Refer to the entire set of contract documents to become familiar with the project. Contractor is responsible for all equipment mounting, conduit routing and incidental work which may be necessary because of construction requirements, whether or not they are shown on the electrical drawings.
- B. The Contractor shall furnish all materials, labor, transportation, tools, permits, fees and incidentals necessary for the installation of a complete electrical system.

- C. It is the intent of the contract documents to provide an installation complete in every respect. In the event that additional details or special construction are required for work indicated or specified, it shall be the responsibility of the Contractor to provide all materials and equipment which are usually furnished with such systems in order to complete the installation, whether mentioned or not.

1.4 PAYMENT RESTRICTIONS

- A. Electrical equipment included in Division 16 shall be paid for in the following payment sequence:
 - 1. 40 Ton Chiller upon equipment delivery – contract amount for 40 Ton Chiller equipment only.
 - 2. 40 Ton Chiller startup and testing – contract amount for successful startup and testing 40 Ton Chiller only.
 - 3. 100 Ton Chiller upon equipment delivery – contract amount for 100 Ton Chiller equipment only.
 - 4. 100 Ton Chiller startup and testing – contract amount for successful 100 Ton Chiller only.
 - 5. Upon completion of system validation for all systems – 20% of the contract amount.
- B. Retainage shall apply to the payment sequence.

1.5 CODES AND STANDARDS

- A. All work shall be in compliance with all applicable portions of the edition recognized by the Authority Having Jurisdiction (AHJ) of the National Electrical Code (NEC), the National Electrical Safety Code (NESC) and all city and county codes and ordinances, which may or may not be specifically referenced in these contract documents. None of the terms or provisions of these contract documents shall be construed as waiving any of the rules, regulations or requirements of these authorities.
- B. In any instance where these contract documents call for construction materials of a better quality or larger size than required by the codes, the provisions of the contract documents shall take precedence. The codes shall govern where violations are indicated in the construction documents. In any instance where there is a conflict between the drawings and specifications, the larger size, higher quantity or better quality shall be provided, unless the Owner's Representative directs otherwise.

1.6 DRAWINGS

- A. The accompanying drawings are intended to show the general arrangement and extent of the work. The exact location and arrangement of all parts shall be determined as the work progresses to conform in the best possible manner with the surroundings and as directed by the Owner and/or Engineer.
- B. If any departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Owner's Representative for review. No departures shall be made without prior written acceptance of the Owner and/or Engineer.

- C. Figured dimensions shall be followed without reference to scale. Where dimensions are not shown, measurements shall be scaled.

1.7 RECORD DRAWINGS

- A. The Contractor shall maintain a set of electrical drawings at the job site neatly marked with all changes from the original contract drawings. Record drawing shall include plan views of all conduit and piping runs. This set of drawings shall not be used for construction purposes and shall be available to the Owner and/or Engineer at all times. Drawings shall be kept up to date as the job progresses and shall be delivered to the Owner and Engineer at the completion of the contract.
- B. The Contractor shall maintain record drawing per the requirements of Division 1.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall furnish of operation and maintenance manuals to the Owner and and/or Engineer per the requirements of Division 1.

1.9 SITE EXAMINATION

- A. The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions and verify all dimensions in the field. The Contractor shall advise the Owner's Representative of any discrepancy at least seven days prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions and the inclusion of all considerations for existing conditions.

1.10 UTILITIES

- A. The contract documents reflect the general location, voltage, capacity, size and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site and to meet with the local utility companies in order to coordinate and confirm the exact requirements for all electrical utilities, including, but not limited to, all facilities required to provide complete and operative electrical power and telephone services. The bid submitted by the Contractor shall include costs for all such coordinative work as well as any and all utility company charges and/or fees.

1.11 TEMPORARY POWER

- A. The Contractor shall coordinate with the Owner, and other trades involved to determine requirements for temporary power on this project. No additional charges shall be made to the Owner for wiring, connections, poles, fixtures or devices required to facilitate construction.
- B. The Contractor shall provide the necessary wiring, connections, service switches, poles, wiring protective devices, lighting fixtures, lamps, outlet devices, disconnect switches, etc., as required for temporary lighting. In addition, a similar system shall be provided for the distribution of single- and three-phase power of voltage levels and adequate ampacity as required to facilitate the construction of the project. These services shall be installed in accordance with requirements of the NEC and OSHA.

1.12 STORAGE AT SITE

- A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is suitable space provided to properly protect equipment from rust, weather, humidity, dust and physical damage.
- B. Store major electrical equipment (switchboards, panelboards, lighting fixtures, dry type transformers, VFDs, etc.) sealed in original factory wrapping in a clean, dry and conditioned environment protected from the weather. Storage outdoors is not acceptable.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL

- A. All materials shall be new and of high quality. All materials of a type for which the Underwriters' Laboratories, Inc. (UL) has established a standard shall be listed by UL and shall bear the UL label.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND COMPLETION OF INSTALLATION

- A. All work shall be performed by competent electricians, skilled in their trade, and shall be executed in a thorough and substantial manner.
- B. The Contractor shall be held responsible for transportation of his materials to and on the job, and for their storage and protection until the final acceptance of the job.
- C. The Contractor shall be held responsible for timely placing of all conduit and outlet boxes, cabinets and other wiring devices in the walls, ceilings, slabs, beams, etc., as construction progresses.
- D. Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds, and all labor required for the safe and expeditious execution of his contract.
- E. All equipment shall be installed in a manner to permit access to parts requiring service. All electrical equipment shall be installed in such a manner as to allow removal for service without disassembly of other equipment, and shall have working clearances as required by NEC. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to fit through finished openings, shall be placed before enclosing structure is completed. Following placement, such apparatus shall be completely protected from damage.
- F. The Contractor shall, at all times, keep the premises free from accumulations of waste material and packaging debris. This debris shall be removed daily from the construction site.

3.2 CUTTING AND PATCHING

- A. Where it becomes necessary to drill or cut through any floors, walls or ceilings to permit the installation of any work under this contract, or to repair any defects that may appear prior to the expiration of the warranty, such cutting shall be done under the supervision of the Owner's Representative by the Contractor. After the necessary work has been completed,

the damage shall be repaired by the Contractor, who shall pay all costs of such cutting and repairing.

- B. No joists, beams, girders or columns shall be cut by the Contractor without first obtaining written permission from the Owner's Representative.
- C. All drilling for expansion bolts, hangers and other supports shall be done by the Contractor, subject to the approval of the Owner's Representative. Labor and materials required to replace or rebuild parts cut or injured shall be furnished at the Contractor's expense, subject to the satisfaction of the Owner's Representative.
- D. All openings made in fire-rated walls, floors and ceilings shall be patched by the electrical contractor in a manner maintaining the original fire rating.

3.3 COORDINATION

- A. The Contractor shall coordinate the work of the different trades so that interferences between piping, equipment, structural and architectural work shall be avoided.
- B. The Contractor is responsible for ensuring that all conduit sleeves are timely installed and are sealed, flashed or caulked to the satisfaction of the Owner's Representative.

3.4 HVAC EQUIPMENT WIRING AND CONTROL

- A. In general, the Contractor shall provide the low-voltage (less than 120 volts) control wiring from the heating, ventilation and air conditioning equipment (HVAC) to the mechanical furnished device (T-STAT, temperature control system, etc.). The electrical drawings will indicate only branch circuit power supplies to serve the HVAC equipment.
- B. If substitution of controls or mechanical equipment for that specified requires any changes in the electrical work, any extra cost of the equipment or electrical work will be the responsibility of the Contractor.

3.5 MISCELLANEOUS

- A. Each piece of floor-mounted equipment, such as switchboards, transformers, etc., shall be set on a concrete base. Bases shall not be less than 4 inches high and shall be pinned to the floor.
- B. The Contractor shall furnish and install vibration isolation means for all equipment and materials furnished under this contract which may transmit perceptible noise or vibration, structure borne or air borne, to occupied areas.
- C. All transformers and other equipment indicated shall be mounted on 1-inch-thick cork rib or rubber pads or steel spring isolator units properly sized, spaced and loaded, as specified herein, which in turn shall rest on a 4-inch minimum concrete base.
- D. Electrical conduit shall be isolated from all dry type transformers and rotating or reciprocating machinery with flexible metal conduit. Use lengths approximately 10 diameters in length.

END OF SECTION

SECTION 16030

EQUIPMENT INSTALLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies receiving, unloading, storing, installing, connecting electrical circuits, and placing in operation all electrical equipment, including but not limited to the following:
 - 1. Disconnect switches.
 - 2. Variable Speed Drives

1.2 RECEIVING, STORAGE, AND HANDLING

- A. Receiving: Receive, uncrate, and inspect equipment for defects or damage. If defective or damaged equipment is discovered, take necessary action to repair or replace equipment. Notify Owner/Engineer if project schedule will be affected.
- B. Storage: Store equipment in dry, clean, and secure area until time of installation.
- C. Handling: Handle equipment in accordance with manufacturer's instructions. Use lifting points where provided to move equipment. Protect painted and machined surfaces where exposed.

PART 2 - PRODUCTS

Not applicable

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Grounding: Comply with Section 16450 for grounding requirements in addition to specific grounding methods covered in the following articles.
- B. Identification: Comply with Section 16195.
- C. Cleaning: Clean interior of enclosures prior to installation of components or pulling conductors.
- D. Supports and Fastenings: Comply with Section 16190.
- E. Enclosure Application:
 - 1. NEMA 1/12 for indoor locations unless indicated otherwise on Drawings.
 - 2. Alum NEMA 3R or stainless steel NEMA 4X for outdoor installations.

3.2 FLOOR OR PAD MOUNTED EQUIPMENT

- A. General: Install floor sills, anchor bolts, shims, and hardware required to level, align, secure, and connect equipment components in accordance with manufacturer's

instructions. Make electrical connections in accordance with Section 16121 for supply and load circuits and leave items in operating condition.

3.3 WALL MOUNTED EQUIPMENT

- A. General:
 - 1. Enclosures:
 - a. Mount enclosures plumb, level, and rigidly attached to structure.
 - b. Mount 1 inch off structure with top 6'-6" above finished floor.
 - c. Install supports in a manner to permit vertical flow of air behind enclosure.
 - d. Use steel supports fabricated from standard rolled structural steel shapes specified in Section 16190.
 - 2. Wiring: Make electrical connections in accordance with Section 16121 for supply and load circuits.
- B. Disconnect Switches: Install properly rated fuses.
- C. Dry-Type Transformers:
 - 1. Mounting: Refer to Section 16190 for proper support and anchorage.
 - 2. Raceway Connections: Connect raceways to transformer enclosure using flexible conduit specified in Section 16111. Use lengths of flex approximately 10 diameters in length.
- D. Panelboards:
 - 1. Enclosure: Close unused circuit positions with blanking plates.
 - 2. Wiring: Check buses for proper insulation resistance prior to energizing.
 - 3. Circuit Breakers: Set circuit breaker instantaneous trip adjustments to minimum setting unless designated otherwise on Drawings.
 - 4. Fusible Units: See section 16416 for fuse requirements.
 - 5. Flush Mounted Panelboards: From each flush mounted panelboard extends into an accessible location a 3/4 inch empty conduit for every three spare branch circuits and spaces or as shown on Drawings.
 - 6. Application:
 - a. Power and Lighting and Receptacle Type Panelboards: As designated by Panelboard Schedules on Drawings.
 - b. Ground Fault Circuit Interrupters: Provide for 120 volt circuits supplying 15 and 20 ampere receptacles installed outdoors or as shown on Drawings.

- E. Molded Case Circuit Breakers: Set adjustable instantaneous trips to minimum, unless indicated otherwise on Drawings. On magnetic breakers in combination with starters, set trips at lowest value that will permit motor starting, but not higher than 13 times motor nameplate full-load current.

- F. Low Voltage Motor Controllers, Variable Speed Drives and Contactors in Individual Enclosures:
 - 1. On motor circuits, connect power circuits for proper phase rotation.
 - 2. Set circuit breaker instantaneous trips at proper value and install correct size fuses and thermal overload heater elements.
 - 3. Check interconnection and operation of control devices, interlocks, indicating lights, and control relays. Set timers and time delay relays for correct intervals. Check controller-operating coil for correct voltage rating. Program relay settings for exterior lighting controls per manufacturer's specification and coordinate time schedules with owner.
 - 4. See Specification Section 16481 - Motor Starters
 - 5. See Specification Section 16484 – Variable Speed Drives

- G. Self-Contained Emergency Power Pack: Connect each unit to equipment ground conductor by means of a crimped ring-type terminal connector secured to housing with a self-tapping screw.

END OF SECTION

SECTION 16111

METALLIC CONDUIT AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Rigid metal conduit (RMC).
- B. Flexible metal conduit.
- C. Liquidtight flexible metal conduit.
- D. Associated fittings.

1.2 QUALITY ASSURANCE

- A. Furnish conduit and fittings bearing UL labels.
- B. Furnish conduit and fittings bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
- C. All exposed conduits shall be RMC.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. RMC: ANSI C80.1 and UL 6, hot dipped galvanized, zinc metalized or sheradized, heavy wall, steel.
- B. Flexible Conduit: Provide flexible conduit sized 1-1/4 inches and smaller that is UL approved for use as a grounding conductor.
 - 1. Flexible Metal (Greenfield): UL 1, hot dipped or electro-galvanized steel.
 - 2. Liquidtight Flexible Metal Conduit (Sealtite): UL 360, hot dipped or electro-galvanized steel with thermoplastic outer covering.

2.2 FITTINGS

- A. Fittings: UL 514B. Provide fittings of same type by same manufacturer.
- B. Conduit Bodies:
 - 1. Zinc coated, cast malleable, ferrous metal, threaded fittings, Appleton "Form 35 Unilets" or Crouse-Hinds "Form 7 Condulets."
 - 2. Conduits 1-1/4 Inch and Larger: Cast malleable or aluminum "Mogul" size bodies.
 - 3. Gaskets: Where installed outdoors or in areas with gasketed enclosures, furnish neoprene cover gasket.

- C. Insulated Bushings:
 - 1. Thermoplastic: Appleton "BBU," O-Z/Gedney "IB," or Thomas & Betts "510" Series.
 - 2. Thermosetting Phenolic: O-Z/Gedney "A."
 - 3. Grounding: O-Z/Gedney "BLG."
- D. Flexible Connectors: Flexible conduit fittings sized 1-1/4 inches and smaller shall be UL approved for use as a grounding device.
 - 1. Metal: Thomas & Betts "3100" series "Tite Bite," insulated.
 - 2. Liquidtight Metal: Thomas & Betts "5200/5300" series or Appleton "ST" series, insulated.
- E. Sealing Hubs: Appleton "HUB" or "HUB-U" series or Thomas & Betts "370" series.
- F. Expansion Fittings:
 - 1. Exposed: O-Z/Gedney type "AX" or "EX" or Appleton type "XJ" with bonding jumper.
 - 2. Concrete Embedded: O-Z/Gedney "DX."
- G. Unions: Appleton type "EC" or Thomas & Betts "670/680" series "Erickson" coupling.
- H. Seals: Provide seals with interior cross section to allow 40% wire fill capacity.
 - 1. Enclosure Termination and Stub-ups Into Switchboards, Distribution Panels, and Other Similar Locations: O-Z/Gedney "CSB" series sealing bushing.
 - 2. "In-Line": Gasketed "C" conduit body, filled with Dow Corning "Fire Stop" sealant.
 - 3. Hazardous Area Seals: Appleton type "EYSEF", "EYDEF", "ESU" or "SF" or Crouse-Hinds type "EYSX", "EZS" or "EYDX" with manufacturer's recommended fiber filler and cement.
 - 4. Miscellaneous Fittings: Locknuts, caps, plugs, reducers, elbows, and other accessories required for a complete installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Submit conduit run plan for approval prior to installation. Include proposed location of all junction boxes including heights.
 - 2. Do not make unnecessary bends or offsets.

3. Do not heat conduits for making bends or bend conduit through more than 90 degrees of arc.
 4. Install conduits so that vertical runs are plumb and horizontal runs are level and parallel or perpendicular to principal structural features.
 5. Maintain 6-inch clearance from steam lines, hot water lines, flues, and other heat producing lines or devices where practicable.
 6. Make up joints tight and do not use running threads.
 7. Clean inside of conduits and swab dry before installing conductors.
 7. Support conduits 2-1/2" and smaller in accordance with NEC. For conduits 3" and larger support at intervals of 10'-0" or less.
- B. Bending Radius: Comply with NEC 344.24 for minimum bending radius on both field bends and factory bends.
- C. Concrete Embedded: Anchor conduit to reinforcing in concrete; plug or cap open ends until concrete and masonry operations are completed.
- D. Below Grade: Encase conduits installed below grade in a 2-inch concrete envelope unless noted otherwise on Drawings.
- E. Conduit Terminations (RMC):
1. NEMA 1 Areas: one interior and one exterior locknut with thermoplastic bushing.
 2. Gasketed Enclosure Areas: One interior locknut and one exterior-sealing locknut with appropriate type bushing.
 3. Outdoor Areas: Use sealing hubs in top and sides of enclosures. Use an exterior locknut, interior sealing locknut, and bushing in bottom of enclosures.
 4. Service Entrances and Circuits above 600 Volts: Same as specified for NEMA 12 areas except use grounding bushing.
- F. Expansion Fittings: Furnish for building expansion joints where conduit is rigidly attached to building structure or rod supported within 18 inches of structure.
- G. Seals:
1. Install seals where conduit passes from a conditioned space into an unconditioned space, in enclosures mounted outdoors, and in conduits entering structures from outside or underground.

3.2 APPLICATION

- A. RMC :
1. Below grade, under load bearing concrete slabs and asphalt roadways unless concrete encased.
 2. Below grade sweeps up to finish floor or grade.

3. Above-grade areas subject to physical damage.
 4. Do not use RMC conduit smaller than 3/4 inch.
- B. Flexible Metal Conduit: Use for final connection to vibrating equipment, enclosed transformers, lay-in lighting fixtures, lighting fixtures with flexible supports, and equipment or devices requiring adjustment, such as motors and limit switches.
1. Greenfield:
 - a. Indoor areas where gasketed enclosures are not required.
 2. Liquidtight:
 - a. Outdoor areas.
 - b. Where gasketed enclosures are required.

END OF SECTION

SECTION 16112

PLASTIC CONDUIT AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Schedule 80 (Sch. 80) poly-vinyl chloride conduit.

1.2 QUALITY ASSURANCE

- A. Furnish conduit and fittings bearing UL labels.
- B. Furnish conduit and fittings bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
- C. PVC conduit is only approved below grade from Ozone Building to condenser.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Sch. 80: NEMA TC 2 and UL 651 rigid poly-vinyl chloride rigid conduit.

2.2 FITTINGS

- A. Plastic Fittings:
 - 1. Sch. 80: NEMA TC 3 and UL 651.
- Seals:
 - 1. Enclosure Termination and Stub-ups Into Switchboards, Distribution Panels, and Other Similar Locations: OZ/Gedney "CSB" series sealing bushing.
 - 2. "In-Line": Gasketed "C" conduit body, filled with Dow Corning "Fire Stop" sealant.
- B. Sealing Hubs: Appleton "HUB" series or Thomas & Betts "370" series.
- C. Miscellaneous Fittings: Locknuts, caps, plugs, reducers, rigid galvanized steel elbows, and other accessories required for a complete installation.
- D. Conduit Cement: Conduit manufacturer's recommended solvent cement.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Do not make unnecessary bends, offsets, or bend conduit through more than 90 degrees.

2. Use manufacturer's recommended heating units for making PVC field bends.
 3. Clean inside of conduits and swab dry before installing conductors.
 4. Support conduits in accordance with NEC.
 5. Install conduits so that vertical runs are plumb and horizontal runs are level and parallel or perpendicular to principal structural features.
 6. Maintain 6-inch clearance from steam lines, hot water lines, flues, and other heat producing lines or devices.
 7. Provide PB max 200' in all UG ducts.
- B. Bending Radius: Comply with NEC for minimum bending radius on field bends and factory bends.
- C. Expansion Fittings: Install across building expansion joints where conduit is rigidly attached to building structure or rod supported within 18 inches of structure and where required to meet thermal expansion in accordance with NEC.
- D. Conduit Terminations:
1. NEMA 12 Areas, Sizes 1 inch and below: PVC terminal adapter with one interior locknut and thermoplastic bushing.
 2. NEMA 12 Areas, Sizes above 1 Inch: PVC terminal adapter with one interior locknut and thermosetting phenolic bushing.
 3. Gasketed Enclosure Areas: PVC terminal adapter with one interior-sealing washer with appropriate type locknut and bushing.
 4. Outdoor Areas: Use sealing hubs in enclosures.
- E. Conduits Below Grade:
1. Circuits of 600 Volts or less: Direct burial not under load bearing concrete slabs and asphalt roadways.
 2. Conduit Bends: Make a transition to rigid steel conduit for elbows, offsets, and stub ups.
 3. Long radius for Comm. Ducts.
- F. Seals: Install seals where conduit passes from a conditioned space into an unconditioned space and in conduits entering structures from outside or underground.

3.2 APPLICATION

- A. Sch. 80:
1. Below grade.
 2. Do not use Sch. 80 conduit smaller than ¾ inch.

END OF SECTION

SECTION 16121

LOW VOLTAGE COPPER WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies copper wire, cable, associated connectors, and termination hardware used on systems operating at 600 volts or less.

1.2 QUALITY ASSURANCE

- A. Furnish wire, cable, associated connectors, and termination hardware bearing UL label.
- B. Furnish wire, cable, associated connectors, and termination hardware bearing the label of, or listed by a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Soft drawn, annealed copper, Class "B" stranding.

2.2 POWER WIRE AND CABLE

- A. Acceptable Manufacturers: Single source manufacture is required for power wire and cable specified in this Section.
- B. General: Conform to UL 83 and NEMA WC 5.
 - 1. Single Conductor: Type THWN-THHN (75°C wet/90°C dry) or XHHW (75°C wet/90°C dry) cable rated 600 volts.

2.3 SIGNAL CABLE

- A. Type PLCC (Power Limited Control Cable):
 - 1. General: Rated 300 volts, 90 deg. C, single pair (Pr.), triad (Tri.) or quad (Qd.).
 - 2. Single Pr., Tri. Or Qd.: No. 16 AWG, stranded copper conductors, twisted and covered with a 100% aluminum-mylar shield, with drain wire and overall PVC jacket.
 - 3. Multiple Pr., Tri. Or Qd.: Same as single construction except No. 20 AWG conductors and an overall aluminum-mylar shield in addition to individual shields.
 - 4. Direct Burial Cable: Same as single or multiple constructions with addition of aluminum sheath and weatherproof outer jacket.

2.4 CONNECTORS AND TERMINALS

- A. Insulated Crimp Type Connectors and Terminals: Nylon insulated, Burndy "INSULINK" and "INSULUG," or Thomas & Betts "Sta-Kon."

- B. Split Bolts: High-conductivity copper alloy, Burndy "SERVIT" or Thomas & Betts "Split-Bolt."
- C. Compression Terminals: Copper long barrel, Burndy "HYLUG" or Thomas & Betts "Color-Keyed," or aluminum alloy Buchanan "Cytolok CL500" series.
- D. Bolted Terminals: Cast copper alloy, Burndy "QIKLUG" or Thomas & Betts "Locktite."

2.5 MISCELLANEOUS COMPONENTS

- A. Tape:
 - 1. Vinyl Plastic: 3M "Scotch 33+" or "Scotch 88."
 - 2. Varnished Cambric (VC): 3M "Irvington 2920."
 - 3. Friction: Black friction tape.
 - 4. Color Coding: 3M "Scotch 35."
 - 5. Fireproofing: 3M "Scotch 77."
 - 6. High Temperature Glass Cloth: 3M "Scotch 69" (180°C).
 - 7. Electrical Insulation Putty: 3M "Scotchfil."
- B. Splice Kits: 3M "Scotchcast 82 Series".
- C. Pulling Lubricants: Ideal "Yellow 77" or Polywater "Type J."
- D. Wire Markers:
 - 1. Individual Wires: Write-on type with self-laminating vinyl overwrap, 3M "ScotchCode," Ideal "Write-On," or Thomas & Betts "WSL."
 - 2. Multi-Conductor Cables or Groups of Wires as a Cable: Nylon tie on marker, Thomas & Betts "Nylon I.D. Ties Ty-Raps."
- E. Wire and Cable Ties: Thomas & Betts "Ty-Raps."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wire and Cable:
 - 1. General:
 - a. Limit pulling tension to maximum values recommended by manufacturer.
 - b. Do not pull through boxes, fittings, or enclosures where a change of raceway alignment or direction occurs. Use of shieves is acceptable.

- c. Do not cut strands from conductors to fit lugs or terminals.
 - d. Do not splice control or signal wiring.
- B. Compression Connectors and Terminals: Install on wire and cable with approved tool and die to recommended compression pressure.
- C. Bolted Connectors and Terminals:
 - 1. Torque to manufacturer's recommended foot-pounds for size and class of connector.
 - 2. Where manufacturer's published torquing requirements are not indicated, tighten connectors and terminals to comply with UL 486A torque values.
 - 3. Use plated bolts and lock washers on terminal connections.
- D. Wiring in Enclosures:
 - 1. Form and tie conductors in panelboards, cabinets, control panels, motor controllers, wireways, and wiring troughs in a neat and orderly manner.
 - 2. Use Thomas & Betts wire and cable ties of appropriate size and type.
 - 3. Limit spacing between ties to not more than 6 inches.
- E. Taping:
 - 1. Above Ground and Dry Locations: Fill voids and irregularities with half-lapped layers of VC (two minimum) or electrical insulation putty. Insulate with three half-lapped layers of vinyl plastic and one half-lapped layer of friction tape.
 - 2. Below Ground and Wet Locations: In lieu of taping protect connection with resin splicing kit.
 - 3. Fireproofing: Same as specified for above ground and dry locations plus one half-lapped layer of fireproofing.
- F. System Separation:
 - 1. Control and Signal Wiring: Provide separate raceways or barriers in raceways to separate each of the following systems from other wiring:
 - a. 120 volt control wiring.
 - b. Analog 4-20 Milliamp.
 - c. Digital (Pulse).
 - d. Digital Communication (Ethernet/DeviceNet) – See Specification 16700

3.2 APPLICATION

- A. Wire and Cable:

1. THWN-THHN or XHHW for power wiring through No. 2 AWG, and control wiring in conduit. XHHW for sizes above No. 2 AWG in conduit.
 2. Bare copper for ground conductors, which penetrate finished floor or grade and ground loops.
 3. No. 12 AWG minimum for power circuits and No. 14 AWG minimum for control circuits unless noted otherwise on Drawings.
- B. Connectors and Terminals:
1. Motor Terminations (Single Conductor Circuits): Insulated ring tongue crimp type connectors or compression terminals, connected back-to-back with plated bolt, nut and lockwasher, and then taped. Where strap screw devices are present use split tongue connectors in lieu of ring tongue connectors.
 2. Motor Terminations (Parallel Conductor Circuits): Gang compression terminals on a 1/4-inch-thick copper bar.
 3. Transformer Terminations: Split bolt connectors for pigtail connections. Compression terminals for all other connections.
- C. Multiconductor Control Cable: 14 AWG conductors except 16 AWG may be used in control enclosures.

3.3 COLOR CODING

- A. Power Wiring: Provide color coding for single and multi-conductor power circuits as follows:

<u>Voltage</u>	<u>ØA</u>	<u>ØB</u>	<u>ØC</u>	<u>Neutral</u>
240 volts and below	Black	Red	Blue	White
250 - 600 volts	Brown	Orange	Yellow	Natural Gray

1. For specified insulations and jackets not manufactured with integral colors, use conductors with black insulation or jacket and color coding tape.
 2. Color code conductors entering boxes, troughs, cabinets, and other enclosures.
 3. Color code conductors in wireways, trenches, and other locations where conductors are continuously accessible at intervals not exceeding 5 feet.
- B. Insulated Equipment Ground: Green.
- C. Control Cables:
1. Single Conductors: Red (AC), Blue (DC).
 2. Multi-conductor: Comply with ICEA S-66-524, "Method 1", Table K-2.

- D. Signal Cables: Comply with ICEA S-82-552, "Method 9", Table E-2. In addition, number multiple pairs, triads, and quads.

3.4 IDENTIFICATION

- A. Cables: Attach nylon tie on markers on both ends of cable denoting cable type and number as noted on Drawings. Where a number of 1/C wires are identified as a single cable, group conductors using "Ty-Raps" and attach markers.
- B. Conductor Identification: Attach conductor markers on both ends of wire and label as indicated on Drawings.

END OF SECTION

SECTION 16130

BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies electrical outlet, device, pull, junction boxes and wireways and installation.

1.2 DEFINITIONS

- A. Outlet Box: A box used as a wiring enclosure that may be used as a device box with the addition of a plaster ring or special cover.
- B. Device Box: A box designed to house a switch, receptacle or other wiring devices.

1.3 QUALITY ASSURANCE

- A. Furnish boxes bearing label or listing of a Nationally Recognized Testing Laboratory (NRTL), as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 OUTLET AND DEVICE BOXES

- A. General:
 - 1. UL 514A and 514B for all boxes.
 - 2. NEMA OS 1 for sheet steel boxes.
- B. Cast Iron Boxes: Crouse-Hinds or Appleton "FS/FD" and "ALC" series.
- C. Cast Aluminum Boxes: Crouse-Hinds "FS-SA"/"FD-SA" or Appleton "FS-A"/"FD-A" Series.
- D. Sheet Steel Boxes: Pressed steel, galvanized, 4 inch octagonal or 4 inch square (or "gang") boxes, depth as needed to accommodate devices and associated wiring.
- E. Accessories: Provide fixture studs, plaster rings, extension rings, and covers as required for application. Galvanized steel indoors and galvanized cast ferrous metal or cast aluminum with neoprene gaskets outdoors.
- F. Floor Boxes;
 - 1. Acceptable Products:

	<u>Hubbell</u>	<u>Steel City</u>
Single-gang box	B-2436	641
Two-gang box	B-4233	642

Three-gang box	B-4333	643
Duplex receptacle trim	S3625	P-64-DU
Telephone/Signal trim	S2425	P-64-3/4-2

2. Accessories: Provide necessary floor covering adapters, plugs, gaskets, nipples and sealing compound.

2.2 JUNCTION AND PULL BOXES

- A. Boxes (6 Inch Minimum Dimension):
 1. Welded galvanized sheet steel, of sizes required by NEC, without knockouts.
 2. 14 gauge metal for boxes with maximum dimension of less than 24 inches, 12 gauge for boxes with maximum dimension of 24 to 35 inches, and 10 gauge for boxes with any dimension greater than 35 inches.
 3. Provide removable, flame retardant, insulating cable supports in boxes with any dimension greater than 42 inches.
 4. Comply with UL 50 for boxes over 100 cubic inches volume.
 5. Provide screwed or bolted covers of same gauge as box.
- B. Boxes (4-11/16 Inch Maximum Dimension): Pressed steel, galvanized, 4 or 4-11/16 inches square, 1-1/2 or 2-1/8 inches deep.
- C. Weatherproof Boxes: NEMA 3R, continuously welded-seam, galvanized sheet steel enclosures with gasketed covers.
- D. Watertight Boxes: Galvanized cast iron with gasketed, bolt-on covers, tapped holes in bosses or hubs for conduit entrances, and integrally cast mounting lugs.

2.3 WIREWAYS

- A. Provide hinged cover NEMA 1 lay-in steel wireway assemblies of sizes indicated on Drawings.
- B. Provide special lengths, telescope fittings, box connectors, elbows and other fittings as required for a complete system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Mount boxes plumb and level and rigidly attach them to the structure.
 2. Clean interiors before installing trim and cover.
 3. Close unused openings with blanking devices or threaded plugs.

4. Install surface mounted units at least 1 inch off of walls with supports placed in such a manner to permit vertical flow of air behind the enclosure.
- B. Wireways:
1. Assemble and erect system so that access covers are on top of horizontal runs
 2. Do not mount wireways directly to building structure or machinery. Use a trapeze assembly to install wireways.

3.2 APPLICATION

- A. NEMA 3R for outdoor installations.
- B. NEMA 1/12 for all other areas unless indicated otherwise on the Drawings.
- C. Cast iron "FS/FD" for use with surface mounted steel conduit unless noted otherwise on the Drawings or in other Specification Sections.
- D. One-piece stamped steel boxes for installation in partitions, walls, and suspended ceilings.
- E. Tile box, 3-½ inch deep for installation in poured concrete walls and concrete columns. 4-inch octagonal box with removable back cover for installation in overhead concrete slabs.

END OF SECTION

SECTION 16136

CLEANING UNDERGROUND CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Clean all new underground conduits following conduit installation and prior to the installation of conductors
2. Clean all existing conduits for which existing conductors are to be removed as indicated in the Drawings.

B. Related Sections:

1. Section 16010 Electrical System General Requirements
2. Section 16111 Metallic Conduit and Fittings

1.2 SUBMITTALS

A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.

B. Following the cleaning of the existing and new underground conduits, provide the following Submittals:

1. Cleaning Report, to include the following information:
 - a. List locations, types and sizes of conduits successfully cleaned.
 - b. Status of conduits which cannot be successfully cleaned (type of conduits, problems encountered, cause of problem, and exact locations measured from 2 adjacent manholes).
 - c. Report general conditions of the ducts (rusting steel, fiber delaminating, etc.).
 - d. Report of Conditions Within Manholes:
 - (1) Unracked cables.
 - (2) Missing or broken parts on cable racks.
 - (3) Equipment that is not grounded to a rod electrode (manhole frame, channel racks, metal ladders, splice shields).
 - (4) Cable arc-proofing damaged or missing.
 - (5) Conduits without end bells.

(6) Broken manhole covers.

e. Comments on any items that require future corrections.

1.3 QUALITY ASSURANCE

- A. Qualifications of Supervisor: The person supervising the Work of this Section shall be personally experienced in this type of Work and shall have been regularly employed by a company engaged in underground pipe or conduit cleaning for a minimum of 2 years.
- B. Furnish to the Owner and Engineer the names and addresses of 3 similar projects which the supervisor has worked on.

1.4 PROJECT CONDITIONS

- A. Existing Conditions: The spare conduits are to be cleaned with all high voltage cables within the manholes and vaults energized.
- B. Protection:
 - 1. Provide electrical insulating blankets, sleeves, gloves, etc., to protect workmen from electrical hazards.
 - 2. Provide heavy blankets, plywood or other devices to protect cables and equipment from physical damage.

PART 2 - PRODUCTS

2.1 DRAG LINE

- A. Minimum 1/8" polypropylene monofilament utility rope:
 - 1. American Synthetic Ropes' Flotorope.
 - 2. Greenlee Tool Co.'s 2 ply Rope 431.
 - 3. Ideal's Pro-Pull Rope 3/16.
 - 4. Thomas Industries/Jet Line Products Rope 232.

2.2 CONDUIT SEALS

- A. Wood or plastic plugs designed for the purpose or a contrasting color cement/sand mixture. Seals shall be removable for future use of conduits. Seals shall include waterproof tag stating "CONDUIT CLEANED" and date (month, year).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Dewater manholes.
- B. Remove all debris from manholes.
- C. Install protective devices on cables and equipment.
- D. Methods used for performing the Work shall have prior approval from the Owner and Engineer.

3.2 PERFORMANCE

- A. Remove all dirt, scale, debris and projections by flushing, rodding, scrapping, wire brushing and swabbing the conduits with hand tools and power equipment designed for the purpose.
- B. Demonstrate to the Owner and Engineer the condition of the cleaned conduits.
 - 1. Use mandrel 1/2" less in diameter than the conduit. Paint sheath of mandrel with black lacquer. Pull mandrel through conduit. Conduit will be considered successfully cleaned if there are no roller marks or scratches on the mandrel.
 - 2. Other methods may be used to determine the status of cleaned conduits, if approved.
- C. Demonstrate to the Owner and Engineer any defect found in the conduits that cannot be satisfactorily eliminated.
- D. Provide a drag line in each cleaned conduit.
- E. Provide conduit seals at both ends of each cleaned conduit.
- F. Remove all debris from conduits and manholes resulting from the work of this Project.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. The Contractor shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install receptacles.
- B. Related Sections: The Contractor shall coordinate the requirements of this Section with the requirements of the Sections listed below.
 - 1. Section 16130, Boxes.
 - 2. Section 16121, Low Voltage Copper Wire and Cable.

1.2 QUALITY ASSURANCE

- A. Comply with applicable provisions and recommendations of the following:
 - 1. National Electrical Code.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Provide submittals for all Receptacles proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Receptacles for Non-Hazardous Locations:
 - 1. Duplex grounding receptacle, two pole, three wire, 125 volt AC, 20 amperes.
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 5362, for dry indoor locations and Catalog No. 53CM62, for wet and corrosive locations, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 5362, for dry indoor locations and Catalog No. 5362-CR, for wet and corrosive locations, by Arrow-Hart Incorporated.
 - (3) Or equal.
 - 2. Single grounding receptacle, two pole, three wire, 125 volt AC, 20 amperes.
 - a. Product and Manufacturer: Provide one of the following:

- (1) Catalog No. 53CM61, by Harvey Hubbell Incorporated.
- (2) Catalog No. 5361-CR, by Arrow-Hart Incorporated.
- (3) Or equal.

B. Ground Fault Receptacles:

1. Duplex receptacle, two pole, three wire, 125 volt AC, 20 amperes.
2. Product and Manufacturer: Provide one of the following:
 - a. Catalog No. GF5362, by Harvey Hubbell Incorporated.
 - b. Catalog No. GF5342, by Arrow-Hart Incorporated.
 - c. Or equal.

C. Surge Suppression Receptacles:

1. Duplex grounding, surge suppression receptacle, two pole, three wire, 125 volt AC, 20 amperes, capable of absorbing a transient surge 6,000 volts minimum. Receptacle to include power on indicator light:
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 5350S by Harvey Hubbell Inc.
 - (2) Catalog No. 5380-GY by Leviton Manufacturing Company.
 - (3) Or equal.

D. Power Receptacles: 480 volt interlocked receptacle with enclosed safety switch service outlet: Provide service outlets, quantity as shown on the Drawings for portable equipment.

1. Material: Copper free aluminum enclosure with operating handle, NEMA 4 with gasketed hinged door.
 - a. Switch: Heavy duty, three pole, with visible blades, a quick make and break mechanism with reinforced, positive pressure type blade and fuse clips. Switch shall be mechanically interlocked with the receptacle. The switch cannot be closed until the plug is fully inserted and the plug cannot be withdrawn or inserted, unless the switch is open.
 - b. Receptacle: As indicated on the drawings. Provide two matching plugs.
 - c. Type WSR, and Type APS plugs by Crouse-Hinds Company or equal.

E. Power and Special Receptacles: Provide receptacles with number of poles and voltage and current rating as shown on the Drawings. Coordinate with equipment plugs. Provide matching plug for each receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install receptacles at locations as shown on the Drawings in outlet or device boxes in accordance with Section 16130, Boxes, in non-hazardous locations.
- B. Install receptacles with ground pole in the down position.
- C. Mount receptacles 18-inches above finished floor, or in accordance with local building codes, in non-hazardous locations and 4 feet-6 inches above finished floor in hazardous locations, unless otherwise noted.
- D. Identify each conductor with the circuit number and the lighting panel number. Identification shall conform to the requirements of Section 16121, Low Voltage Copper Wire and Cable.
- E. Identify each receptacle with a permanent phenolic tag. The tags shall include the circuit number and the lighting panel number.
- F. Installation shall conform to the National Electrical Code.

END OF SECTION

SECTION 16150

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install snap switches for lighting and other systems.
- B. Related Sections: Contractor shall coordinate the requirements of the work in this section along with the requirements of the sections listed below which include, but are not necessarily limited to, work that is directly related to this Section.
 - 1. Section 16130, Boxes.
 - 2. Section 16121, Low Voltage Copper Wire and Cable.

1.2 QUALITY ASSURANCE

- A. Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
 - 1. National Electrical Code.
 - 2. UL Standard No. 20, General Use Snap Switches.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Provide Submittals for all switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Switches for Non-Hazardous Locations:
 - 1. Single pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 1221-I, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 1991-I, by Arrow-Hart Incorporated.
 - 2. Single pole, 3-way AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.

- a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 1223-I, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 1993-I, by Arrow-Hart Incorporated.
- 3. Two pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 1222-I, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 1992-I, by Arrow-Hart Incorporated.
- B. Switch Covers:
 - 1. Indoor covers shall be Type 304, stainless steel.
 - 2. Outdoor or wet location covers shall be weatherproof and corrosion resistant.
- C. Key Operated On-Off Switches:
 - 1. Key operated switches shall be complete with legend plate and NEMA 4 enclosure and two keys for each switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switches at locations as shown on the Drawings in outlet or device boxes in accordance with Section 16130, Boxes, in non-hazardous locations.
- B. Mount wall switches 4 feet-6 inches above finished floor unless otherwise noted.
- C. Identify each conductor with the circuit number and the lighting panel number. Identification shall conform to the requirements of Section 16121, Low Voltage Copper Wire and Cable.
- D. Install switches in conformance with National Electrical Code.

END OF SECTION

SECTION 16190

SUPPORTS AND FASTENERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Supports and hangers, anchors, and fastenings for mounting and anchoring electrical raceways, equipment, and fixtures.
- B. Related Sections: Additional support requirements for specific items are specified elsewhere in Division 16.

PART 2 - PRODUCTS

2.1 FIELD FABRICATED SUPPORTS

- A. Structural steel shapes and plates as specified in Division 5. Hot-dipped galvanized for outdoor locations.
- B. 3/8 inch minimum, continuous thread, plated or galvanized hanger rod.
- C. Prefabricated structural systems manufactured by American Electric Kindorf, Power-Strut, or Unistrut.

2.2 CONDUIT SUPPORTS

- A. Clamps: Steel City or American Electric Kindorf "RC" and "PC" clamps.
- B. Straps:
 - 1. Conduit Straps: Plated steel or hot-dipped galvanized, "two-hole" straps.
 - 2. Channel Straps: American Electric Kindorf "C-105," Power-Strut "PS-1300," or Unistrut "P1100" and "P1400."
- C. Hangers:
 - 1. Conduit Hangers: Steel City Series "6H" or Erico Products, Inc. Caddy "CD" series.
 - 2. Lay-In Pipe Hangers: American Electric Kindorf "C-149," Power-Strut "PS-3200," or Unistrut "J1200."
- D. Clips: Erico Products, Inc. "Caddy M" Series snap-lock conduit clip in combination with a "Caddy Universal" drive-on beam clamp or threaded rod.

2.3 ANCHORS

- A. Toggle Bolts: Star "3000" series.
- B. Plastic Anchors: Star "06" series with appropriately sized metal screws.

- C. Lead Shields and Lag Bolts: ITW Ramset/Red Head "LS" series or Star "1800" series.
- D. Hollow Wall Anchors: ITW Ramset/Red Head "WA" series or Star "2700" series.
- E. Threaded Expansion Anchors: ITW Ramset/Red Head "J," "S" or "JS" series, or Star "3400" series.
- F. Wedge Anchors: ITW Ramset/Red Head "WS" series or Star "3500" series.

2.4 FASTENERS

- A. Bolts and Nuts: ASTM Grade 2, low carbon, plated or galvanized, hex head.
- B. Beam Clamps: American Electric Kindorf "E-160" or "E-231," Power-Strut "PS800" and "PS2000," or Unistrut "P2600" or "P2700" clamps with retainers.
- C. Channel/Angle Clamps: American Electric Kindorf "E-177" or equal.

2.5 GALVANIZING REPAIR PAINT

- A. ASTM A 780.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Fabricate and install supports so that supported installation does not weaken or overload structure.
 - 2. Do not impose weight of electrical equipment, raceways, or fixtures on supports provided for non-electrical systems unless indicated otherwise on Drawings.
 - 3. Secure steel supports to structure by bolting or welding.
 - 4. Use retaining device when making connections with setscrew-type beam clamps or C-clamps.
 - 5. Maximum diameter of drilled holes in beam flanges shall not exceed 15% of width of flange.
 - 6. Drill holes to leave minimum of 1/2 inch of steel from edge of member to edge of hole.
 - 7. Support loads from bottom chord member of trusses or steel joists only where diagonal members attach to bottom chord.
 - 8. Do not support loads from metal roof or floor decking.
 - 9. Do not weld to steel joist.
- B. Outdoor Supports: Coat bolted and field welded supports with galvanizing repair paint.

3.2 APPLICATION

- A. Supports for Single Conduits:
 - 1. Conduit in Direct Contact with Steel Framing: "RC" and "PC" clamps.
 - 2. Suspended Conduit 1-1/4 Inch and Below: Hanger rod and conduit hanger.
 - 3. Suspended Conduit 1-1/2 Inch and Above: Hanger rod and lay-in pipe hanger.
 - 4. On Walls: Steel "one-hole" straps.
- B. Supports for Multiple Parallel Conduits:
 - 1. In Direct Contact with Steel Framing: Attach prefabricated 1-1/2 inch wide channel, of sufficient depth to support the load, directly to framing and attach conduits to channel straps.
 - 2. Suspended: Assemble a "trapeze" hanger using prefabricated 1-1/2 inch wide steel channel of sufficient depth to support load, and two (2) or more hanger rods. Attach conduits to channel using channel straps.
- C. Wall Anchors:
 - 1. Hollow Masonry Units: Support light loads such as one and two-hole straps, and outlet boxes with plastic anchors and screws. Support heavy loads such as panelboards, safety switches, and multiple conduit runs with toggle bolts.
 - 2. Solid Masonry Units: Lead shields and lag bolts; use through-bolts for tension loads.
 - 3. Gypsum Board: Hollow wall anchors.
- D. Concrete Floor and Overhead Slabs:
 - 1. For overhead equipment loads less than 400 lbs., use at least two (2) 3/8-inch minimum diameter threaded expansion anchors. For equipment loads in excess of 400 lbs., but less than 1,000 lbs., use at least two (2) 3/8-inch minimum diameter wedge anchors.

END OF SECTION

SECTION 16195

IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Identification and information signs and warning signs for electrical equipment.
- B. Related Sections: Additional identification requirements for specific items are specified elsewhere in Division 16. See Specification Section 16121, Low Voltage Copper Wire and Cable for wire identification.

1.2 APPLICABLE STANDARDS

- A. OSHA Subpart S.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Identification and Information Signs:
 - 1. Rigid laminated phenolic, per owner specific color requirements.
 - 2. Text size for equipment designations shall be as large as space allows, up to 1-1/2" maximum.
 - 3. 1/2-inch minimum text size.
 - 4. Contractor shall submit proposed lettering for approval by Owner.
 - 5. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified and scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.
- B. Warning Signs:
 - 1. OSHA Subpart J - General Environmental Controls, Section 1910.145.
 - 2. Signs provided with equipment are acceptable provided all necessary signs are issued with equipment.
 - 3. Provide identical signs for each application.
 - 4. High voltage warning signs to read "DANGER - HIGH VOLTAGE - KEEP OUT."
- C. Panelboard Directories: Refer to Section 16470.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification and Information Signs:
 - 1. Location: Place signs on the following equipment:
 - a. Power distribution switchboards.
 - b. Power distribution panels.
 - c. Panelboards.
 - d. Dry-type transformers.
 - e. Individually mounted motor controllers.
 - f. Control panels.
 - g. Safety/disconnect switches.
 - h. Junction boxes
 - i. Match to the Cities existing color code scheme. This work is within the Blue Substation distribution system and shall be color coded white letters on a blue background.
 - 2. Minimum Information on Sign: Include the following information:
 - a. Equipment Designation.
 - b. Operating Voltage.
 - c. Served From equipment designation.
 - d. For branch circuit panelboards, include color coding for phase, neutral, and ground conductors for each voltage system used in accordance with NEC paragraph 210-5(c).
 - 3. Equipment Served Identification: Include Equipment Served on identification and information signs for the following equipment:
 - a. Dry-type transformers.
 - b. Individually mounted motor controllers.
 - c. Safety/disconnect switches.
- B. Panelboard Directories. Provide fully completed typewritten circuit directory cards. Identify each circuit using descriptions contained in panelboard schedules on Drawings.
- C. Mounting: Mount signs to clean, dry equipment surface with an epoxy adhesive.
- D. All labels/names of equipment must be submitted for review and approval.

END OF SECTION

SECTION 16416

FUSES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions. Comply with the provisions and requirements of Section 01330, Submittal Procedures

1.2 MAINTENANCE

- A. Spare Parts:
 - 1. Six spare fuses of each size and category, including any accessories required for a complete installation.
 - 2. Special tools if required for installation or removal of fuses.

PART 2 - PRODUCTS

2.1 FUSEHOLDERS

- A. Equipment provided shall be furnished with fuseholders to accommodate the fuses specified.

2.2 FUSES RATED 600V OR LESS

- A. Fuses for Safety Switches (Motor Circuits) and Service Disconnects:
 - 1. Cartridge Type (250 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-5, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussman Div. Type FRN-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type TR-R.
 - c. Littlefuse Inc.'s Type FLN-R.
 - 2. Cartridge Type (600 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-5, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussmann Div. Type FRS-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type TRS-R.
 - c. Littlefuse Inc.'s Type FLS-R.
 - 3. Cartridge Type (600 Volts or Less - Above 600 Amperes): Current limiting, UL Class L, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussmann Div. Type KTU.

- b. Gould Inc.'s Circuit Protection Div. (Shawmut) Type A4BY.
 - c. Littlefuse Inc.'s Type KLP-C.
- B. Fuses for Safety Switches (Lighting and Heating Circuits):
 - 1. Cartridge Type (250 Volts): Single element, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussmann Div., Type KTN-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type A2K-R.
 - c. Littlefuse Inc.'s Type KLN-R.
 - 2. Cartridge Type (600 Volts): Single element, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussmann Div. Type KTS-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type A6K-R.
 - c. Littlefuse Inc.'s Type KLS-R.

2.3 FUSES RATED OVER 600V

- A. Fuses for Metal Enclosed Interrupter Switchgear:
 - 1. Current Limiting, Silver-Sand Type: General Electric Co.'s Type EJ, or Westinghouse Elec. Corp.'s Type CLE.
 - 2. Boric-Acid Type: S & C Electric Co.'s Type SM with snuffler, or Westinghouse Elec. Corp.'s Type RBA with condenser.
- B. Fuses for 35KV Service Switch and Fuse Assembly: S & C Electric Co.'s Type SM-5.
- C. Fuses for Pad Mounted High Voltage Switch and Fuse Assembly: S & C Electric Co.'s Type SML.
- D. Fuses for Fused Load Break Interrupter Switches: General Electric Co. Type EJ, S & C Electric Co.'s Type SM, or Westinghouse Electric Corp.'s Type CLE.
- E. Fuses for Distribution Oil Cutouts: General Electric Co.'s Fuse Links 9F57CAA, or G & W Electric Co.'s Type FL.
- F. Fuses for Primary Cutouts:
 - 1. Cutouts Rated 5.2KV: EEI-NEMA standard Type K (fast) distribution fuse links; Westinghouse Electric Corp.'s Universal Cable Type Fuse Links Series 632AO--A01.

2. Cutouts Rated 14.4KV: EEI-NEMA standard Type K (fast) distribution fuse links; S & C Electric Co.'s 265000 Series, or Westinghouse Electric Corp.'s Universal Cable Type Fuse Links Series 632A0--A01.
3. Cutouts Rated 38KV: EEI-NEMA standard Type K (fast) distribution fuse links, to suit primary cutouts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in respective equipment.

END OF SECTION

SECTION 16440

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies fusible and non-fusible safety and disconnect switches, individually enclosed and group mounted or applied in combination with motor controllers/contactors in single or grouped installations.

1.2 QUALITY ASSURANCE:

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, disconnect switches shall comply with the requirements of NEMA 250, NEMA KS 1, and UL 98.
- C. UL Labeling or Listing: Furnish switches bearing UL label.
- D. NRTL Labeling or Listing: Furnish switches bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS

- A. Submit Product Data on each switch showing ratings, overall dimensions, enclosure type, and accessories, in accordance with Section 01330, Submittal Procedures.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General: Fusible and non-fusible "Heavy Duty" safety and disconnect switches with ratings as shown on Drawings and 75°C or higher temperature rating.
- B. Components:
 - 1. Line terminal shields.
 - 2. Visible blades.
 - 3. Non-teasible, positive, quick-make, quick-break interrupter operating mechanism.
 - 4. Reinforced Class R rejection-type fuse clips.
 - 5. Handle whose position ("OFF" or "ON") is easily recognizable and can be multiple padlocked in "OFF" position.
 - 6. Defeatable door interlocks that prevent door from opening when operating handle is in "ON" position.
 - 7. Auxiliary control contact operated by handle mechanism to signal that switch is in the closed position where indicated on Drawings.

WTP OZONE GENERATION BUILDING CHILLER REPLACEMENT

8. Factory installed ground lugs.
 9. Factory installed cover mounted metal nameplate containing a permanent record of:
 - a. Switch type.
 - b. Catalog number.
 - c. Horsepower ratings using both standard and time delay fuses.
- C. Horsepower Ratings:
1. Horsepower rated switches for use as motor disconnecting means, with sizes in accordance with individual manufacturer's published ratings.
 2. For applications in excess of switch ratings, provide non-automatic molded case circuit breakers rated not less than 125% of motor full load current.
- D. Fuses: Current-limiting-type UL RK1 with a minimum interrupting rating of 200,000 RMS symmetrical amperes and of continuous current ratings as shown on Drawings.
- E. Enclosures:
1. NEMA 1/12 for dry, indoor areas.
 2. NEMA 3R for damp indoor or outdoor locations.
 3. Others as noted.
- F. Acceptable Manufacturers:
1. General Electric Company.
 2. Square-D Company.
 3. Siemens

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Enclosure:
1. Mount switch enclosure plumb and level and rigidly attach to structure.
 2. Mount 1 inch off structure with top 6'-6" above finished floor.
 3. Install supports in a manner to permit vertical flow of air behind enclosure.
 4. Use steel supports fabricated from standard rolled structural steel shapes as specified in Section 16190.
- B. Wiring: Install all incoming and outgoing power circuits.

- C. Grounding: Refer to Section 16450.
- D. Fuses: Install properly rated fuses.

3.2 IDENTIFICATION

- A. Refer to Section 16195.

END OF SECTION

SECTION 16450

GROUNDING

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies grounding of electrical systems and equipment and grounding of conductive machine frames, enclosures, appliances, structures and other equipment for protection of life, equipment, circuits, and systems.
- B. All switchboards, transformers, load break switches and metering shall be grounded per the Utility and NEC requirements.

1.2 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, Grounding shall comply with the requirements of IEEE 142, NFPA 70 Article 250 and UL 467.
- C. UL Labeling or Listing: Furnish grounding fittings bearing label of or listing by UL.
- D. NRTL Labeling or Listing: Furnish grounding fittings bearing label of or listing by a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS

- A. Test Reports: Submit to Engineer two (2) copies of grounding system test report certified by testing technician and Owner's representative, in accordance with Section 01810, Commissioning.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Conductors: Copper, refer to Section 16121.
- B. Exothermic Welding: Molds and charges by Erico Products, Inc. "Cadweld" or Continental Industries, Inc. "Thermoweld".
- C. Ground Rods: (5/8)-inch diameter, 10 feet long, copperclad sectional ground rods.
- D. Grounding Clamps: O-Z/Gedney or Steel City "G" series.
- E. Connectors, Terminals, and Tape: Refer to Section 16121.
- F. Flexible Conduit Connectors: Refer to Section 16111.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install grounding system comprised of the following major components:
1. Steel reinforcing bars in column footings with Eufel ground bonded together as grounding electrodes to provide connection to earth.
 2. Ground loop.
 3. Driven rod at service entrances.
 4. Continuous equipment grounding conductors in electrical raceways and cable runs to ensure a positive path for connection of equipment that must be grounded.
 5. Water pipe electrode.
 6. Continuous bond of all items listed above. Connection of Equipment to Framing
- C. Steel:
1. General: Connect below grade and concealed conductors using exothermic welds. Connect above grade using mechanical connectors.
 2. Transformer Neutrals: Connect 9 KVA and larger transformer neutrals to the grounding system using conductor sized in accordance with NEC Table 250.66 but no smaller than No. 2 AWG.
 3. Distribution Equipment: Connect ground bus in switchgear assemblies, motor control centers, motor control panelboards, and power panelboards to the grounding system using a conductor sized in accordance with NEC Table 250.122 but no smaller than No. 2 AWG.
 4. Motor Frames: Connect motor frames rated above 300 volts and located within 6 feet above finished floor to the grounding system using a conductor sized in accordance with NEC Table 250.122 but no smaller than a No. 2 AWG.
 5. Tanks and Vessels: Provide No. 2 AWG conductor from each metal tank or vessel to the nearest grounding system.
 6. Telephone Equipment: Provide No. 4/0 AWG conductor from the grounding system into each telephone equipment room or telephone service entrance terminal cabinet and terminate as directed by the telephone company.
- D. Equipment Grounding:
1. Provide electrically continuous equipment grounding conductors sized per NEC Table 250.122, or as indicated on Drawings, in electrical raceways containing conductors rated higher than 30 volts.

2. Bond grounding conductors to grounding bushings, grounding locknuts, grounding lugs, equipment, fixtures, enclosures and transformer neutrals.
- E. Flexible Metal Conduit: Provide an external grounding jumper on flexible conduit runs longer than 6 feet.
1. Spiral wrap the grounding conductor through a minimum of 360° around outside of flexible conduit.
 2. Terminate jumper and flex on each end with an insulated grounding fitting.
 3. Size jumper same as equipment grounding conductor in the flexible conduit but no smaller than No. 6 AWG.
- F. Expansion Joints: Provide No. 4/0 AWG jumper with 6 inches of sag across structure expansion joints.
1. Bond jumpers to framing steel on both sides of the joint using exothermic welds.
 2. Provide a jumper every 50'-0" maximum along expansion joint with a minimum of two jumpers per expansion joint.

END OF SECTION

SECTION 16461

DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies general purpose and specialty dry-type transformers with windings rated 600 Volts or less.

1.2 RELATED SECTIONS

- A. Section 16010, Electrical System General Requirements
- B. Section 16011, Submittal Procedures
- C. Section 16012, Electrical Product Substitution Procedures
- D. Section 16030, Equipment Installation
- E. Section 16195, Identification
- F. Section 16450, Grounding

1.3 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, dry-type transformers shall comply with the requirements, ANSI/IEEE C57.12.01., NEMA ST 1., NEMA ST 20., UL 506., and UL 1561.
- C. UL Labeling or Listing: Furnish transformers bearing UL label.
- D. NRTL Labeling or Listing: Furnish transformers bearing the label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.4 SUBMITTALS

- A. Submit Product Data on each transformer showing ratings, number of phases, winding configuration, KVA capacities, overall dimensions, and weight in accordance with Section 01330, Submittal Procedures.
- B. Submit one copy of manufacturer's sound rating certification.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General: Provide transformers with the following characteristics:

1. Ratings, Configurations, and Capacities: Primary and secondary voltage ratings, number of phases, winding configuration, and KVA capacities as shown on the Drawings.
 2. Windings: Electrical Grade Copper, two windings per phase, totally enclosed, non-ventilated, self-cooled. Aluminum windings are not permitted.
- B. Shielded isolation transformers shall be provided with an electrostatic shield between the primary and secondary windings.
- C. Primary Taps:
1. Below 30 KVA: 2@ 5% FCBN.
 2. 30 KVA and Above: 2@ 2-1/2% FCAN and 4@ 2-1/2% FCBN.
- D. Insulation: BIL shall be a minimum of 10kV.
1. Below 30 KVA: Class 185.
 2. 30 KVA and Above: Class 220.
- E. Temperature Rise (Over 40°C Ambient):
1. Below 30 KVA: 115°C.
 2. 30 KVA and Above: 150°C.
- F. Sound Rating: Do not exceed ANSI and NEMA maximum levels for specified KVA capacities. Sound levels shall be guaranteed by the manufacturer not to exceed the following.
1. 45db for transformers 15-50 kVA
 2. 50db for transformers 51-300 kVA
 3. 55db for transformers 301-500 kVA
- G. Sound levels for transformers mounted in Hospitals, Schools, Office Areas and other sensitive areas shall be nominally 5 db below ANSI levels referenced in paragraph 2.1 G above. Note: "other sensitive areas" will be designated on the drawings.
- H. Enclosure: Suitable for indoor locations (NEMA 1) or outdoor (NEMA 3R) locations with the addition of weathershield kit and including a wiring compartment suitable for conduit entry. All transformers shall be provided with rodent screens. Transformers through 75 kVA shall be designed so they can be either floor or wall mounted. Above 75kVA they shall be of a floor mounted design.
- I. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed and finished with grey, baked, enamel.

- 2.2** Buck/boost transformers shall be encapsulated type, suitable for 80°C rise in 40°C ambient. Secondary windings shall be rated 12/24V and/or 16/32V as indicated on the drawings.
- 2.3** Provide transformer with engraved nameplates with designation as indicated on the drawings or as directed by the Owner's Representative in accordance with Section 16195 – Identification.
- 2.4 ACCEPTABLE MANUFACTURERS:**
- A. General Electric Company.
 - B. Square-D Company.
 - C. Siemens.

PART 3 - EXECUTION

3.1 INSTALLATION.

- A. Mounting: Refer to Section 16190 for proper support and anchorage. Provide 4-inch tall concrete housekeeping pads when transformers are mounted in equipment rooms or areas subject to occasional moisture on the floor. In all outdoor locations concrete transformer pads are required.
- B. Raceway Connections: Connect raceways to transformer enclosure using flexible conduit as specified in Section 16111. Use pieces of flex approximately ten diameters in length.
- C. Wiring: Terminate wiring connections in accordance with Section 16121.
- D. Grounding: Refer to Section 16450.
- E. Assure National Electrical Code clearances on all sides for adequate ventilation.
- F. Transformers shall be installed in accordance with manufacturer's recommendations. In addition, all transformers shall be installed with Isomode, Aeroflex or Energy Kinetics vibration isolation devices under feet or contact points.
- G. Adjust transformer taps for proper secondary voltage.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies circuit breaker and fusible panelboards for use in control and protection of lighting, receptacle, and general power loads rated 600 volts or less.

1.2 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, panelboards shall comply with the requirements, NEMA PB 1, NEMA PB 1.1, and UL 67
- C. UL Labeling or Listing: Furnish panelboards bearing UL label.
- D. NRTL Labeling or Listing: Furnish panelboards bearing the label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS

- A. Submit Product Data on each panelboard in accordance with Section 01330, Submittal Procedures, including:
 - 1. Enclosure dimensions and type.
 - 2. Voltage and number of phases.
 - 3. Bus material, ampere rating, and bracing.
 - 4. Overcurrent device frame designations, trip ratings, and interrupting rating.
 - 5. Customer's panelboard designation.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General: Conform to schedules and diagrams as shown on Drawings. Each schedule shall indicate:
 - 1. Panelboard designation.
 - 2. Arrangement diagram.
 - 3. Current and voltage ratings for each component.

B. Acceptable Manufacturers: Single source manufacture is required. Provide factory-assembled panelboards as follows:

1. Power, Lighting and Receptacle Panelboards (PP & RP):

a. 480/277 Volt: Power Panelboard

<u>Manufacturer</u>	<u>Type</u>
General Electric Co.	AE
Square D Co.	NF
Siemens	S2

b. 208/120 or 120/240 Volt: Receptacle Panelboard (RP)

<u>Manufacturer</u>	<u>Type</u>
General Electric Co.	AQ
Square D Co.	NQOD
Siemens	S1

C. Bus Work: Copper bus bars, isolated neutral bar as indicated on schedules, and grounding bar. Bond grounding bar to panelboard enclosure.

D. Enclosure:

1. Minimum Widths:

a. Power Panelboards: 24 inches.

b. Lighting and Receptacle Panelboards: 20 inches.

E. Enclosure Doors and Trim:

1. Door Locks: Provide each door with a pin-cylinder type lock. Key locks alike.

2. NEMA 1 Door/Trim: Steel with primed and baked-on gray enamel and of "door-in-door" construction.

a. Hinge outer door to box so that access to wiring gutters is provided.

b. Hinge inner door to outer door so that dead-front access to the overcurrent device operators is provided.

3. NEMA 1 Door/Trim: Steel with primed and bake-on gray enamel.

a. Attach trim to box with rotating quarter-turn clamps or similar clamping system.

b. Hinge door to trim so that dead-front access to the overcurrent devices is provided.

4. NEMA 3R Door/Trim: Steel with primed and bake-on gray enamel.

- a. Hinge weatherproof, gasketed trim to side of box so that access to wiring gutters is provided.
 - b. Hinge weatherproof, gasketed door to trim so that dead-front access to over current device operators is provided.
- F. Circuit Breakers: Refer to Section 16475.
- 1. Trip ratings, frame sizes, and interrupting ratings are shown on Drawings.
 - 2. Ground fault circuit interrupters with sensitivity trip level of 5 milliamperes, trip indication, and test button.
- G. Fused Switches: Refer to Section 16440.
- H. Panelboard Directory: Provide each panelboard with a circuit directory card mounted in a holder located on inside of door. The circuit directory shall have the same data fields as the panelboard schedules included in the project plans. The Contractor shall revise and update all load data fields as necessary due to field changes and actual load data as specified on equipment nameplates.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Enclosure:
- 1. Mount enclosures plumb and level, 6'-6" to top, and rigidly attach to structure using materials and methods specified in Section 16190.
 - 2. Install surface mounted units in a manner to permit vertical flow of air behind cabinets and enclosures.
 - 3. Clean interiors before installing trim.
 - 4. Close unused circuit positions with blanking plates.
- B. Wiring:
- 1. Install wiring in accordance with Section 16121.
 - 2. Check buses for proper insulation resistance prior to energizing.
 - 3. Connect grounding conductors and conduit bushing grounding terminals to panelboard grounding bar.
- C. Circuit Breakers: Set circuit breaker instantaneous trip adjustments to minimum setting unless designated otherwise on Drawings.
- D. Fusible Units: Provide full complement of fuses of designated class and ratings and 10% (minimum of 3) spare fuses of each size specified.
- E. Flush Mounted Panelboards: From each flush mounted panelboard extend into an accessible location a 3/4 inch empty conduit for every three spare branch circuits and spaces or as shown on Drawings.

3.2 APPLICATION

- A. Power, Lighting and Receptacle Type Panelboards: As designated by Panelboard Schedules on Drawings.
- B. Enclosure:
 - 1. NEMA 1 for indoor locations unless indicated otherwise on Drawings.
 - 2. NEMA 3R for outdoor installations.
- C. Ground Fault Circuit Interrupters: Provide for all 120 volt circuits supplying 15 and 20 ampere receptacles installed outdoors or as shown on Drawings.

3.3 IDENTIFICATION

- A. Refer to Section 16195.

END OF SECTION

SECTION 16475

MOLDED CASE CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies molded case circuit breakers in individual enclosures, panelboards, combination motor starters, and control panels.

1.2 RELATED SECTIONS

- A. Section 16010, Electrical System General Requirements
- B. Section 16011, Submittal Procedures
- C. Section 16012, Electrical Product Substitution Procedures
- D. Section 16030, Equipment Installation

1.3 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, molded case circuit breakers shall comply with the requirements of:
 - 1. NEMA AB 1.
 - 2. UL 489.
- C. UL Labeling or Listing: Furnish circuit breakers bearing UL label.
- D. NRTL Labeling or Listing: Furnish circuit breakers bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.4 SUBMITTALS

- A. Submit Product Data on each circuit breaker showing ratings, overall dimensions, enclosure type, and accessories in accordance with Section 01330, Submittal Procedures.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General:
 - 1. Voltage rating for the point of application, frame size, trip rating, and interrupting rating are noted on Drawings.
 - 2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism. Automatic tripping of the breaker shall be clearly indicated by handle position. Contacts shall be non-

welding silver alloy and arc extinction shall be accomplished by means of arc chutes.

3. All breakers shall be "bolt on" type.
4. When used for switching lighting circuits, breakers shall be marked "SWD" (Switch Duty Rated).
5. All multi-pole breakers shall have common trip. Wires, pins, etc., between single pole breakers to form common trip will not be acceptable.
6. The use of "Pushmatic" or miniature "Quicklag" breakers shall not be permitted.
7. Provide individually enclosed and panelboard mounted circuit breakers of the thermal-magnetic type with inverse time and instantaneous trip characteristics rated for operation in a 40°C ambient.
8. Provide breakers used in combination with motor starters with adjustable instantaneous trips.
9. Provide shunt trip devices, motor operators, interlocks, auxiliary contacts, bell alarm switches, and other modifications as noted on Drawings or specified in Section 16481.
10. Do not use "trunk type" latches on enclosures.

B. Enclosures:

1. NEMA 1 for dry, indoor areas.
2. NEMA 3R for damp or outdoor locations.
3. Other ratings as noted.

C. Acceptable Manufacturers:

1. General Electric Company.
2. Square D Company.
3. Siemens.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Mounting: Refer to Section 16190. Mount individually enclosed circuit breakers with top of enclosure 6'-6" above finished floor unless indicated otherwise on Drawings.

- B. **Trip Settings:**
- C. Set adjustable instantaneous trips to minimum, unless indicated otherwise on Drawings.
- D. On magnetic breakers in combination with starters, set trips at the lowest value that will permit motor starting, but not higher than 13 times the motor nameplate full-load current.

3.2 IDENTIFICATION

- A. Refer to Section 16195.

3.3 TESTING

- A. Refer to Section 16955.

END OF SECTION

SECTION 16481

MOTOR STARTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual motor starters.
- B. Combination magnetic motor starters.

1.2 RELATED SECTIONS

- A. Section 16010, Electrical System General Requirements.

1.3 REFERENCES

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.

1.4 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Product Data: Provide dimensions, mounting, weight, electrical ratings, control schematics, wiring diagrams and recommended overload heater sizes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. General Electric
- B. Square D
- C. Siemens

2.2 MANUAL MOTOR STARTERS

- A. Shall have "quick-make, quick-break" toggle mechanism.
- B. Overload heater(s) shall be sized per motor nameplate and manufacturer's recommendations.
- C. Provide NEMA Type 1 enclosure unless otherwise shown on the drawings.
- D. Shall be suitable for the voltage, HP and the number of phases as shown on the drawings.

2.3 COMBINATION MAGNETIC MOTOR STARTERS

- A. Starters shall be combination, full voltage, nonreversing unless shown otherwise, and shall utilize motor circuit protectors or fusible switches as shown on the drawings.

- B. Starters shall be equipped with a fused control power transformer, 120-volt operating coil, ambient compensated overload relays and one NO and one NC spare auxiliary contacts wired to the terminal strip.
- C. Each starter shall be provided with the control devices shown on the drawings. If control schematics are not shown on the drawings, provide the following:
 - 1. A 'HAND-OFF-AUTO' selector switch mounted on the cover.
 - 2. A red 'RUN' light and green 'STOP' light.
 - 3. The 'AUTO' side of switch shall be wired to the external terminal strip for connection to a field-mounted control device (chiller controls).
- D. Control power transformers shall be sized for the operating coil and any other loads shown on the drawings. One side of the control power transformer shall be grounded. Primary fusing shall be provided in accordance with the NEC.
- E. Motor circuit protectors (MCP) shall provide adjustable magnetic protection and be provided with a pin insert to stop the magnetic adjustment at 1,300 percent motor nameplate full load current. The MCP shall have a "tripped" position on the unit disconnect and a push-to-test button on the MCP. The MCP shall include a transient override feature for motor inrush current.
- F. Fuses used in fused switches shall be in accordance with Section 16050. Fuse clips shall be rejection type accepting only current limiting fuses.
- G. Overload heaters shall be sized per motor nameplate and manufacturer's recommendations. A manual reset button shall be provided on the cover of the door.
- H. Control accessories shall be heavy-duty oil tight type. Indicating lights shall be transformer type with 6.3-volt lamps and push-to-test feature.
- I. Hour meters (elapsed time meters) shall be 2-1/2-inch square case type for flush panel mounting. The meter face shall have black trim on white or aluminized face. The meters shall have a six-digit nonreset register with the last digit indicating tenths of an hour.
- J. Terminal strips shall be provided for connection to external devices.
- K. Enclosures shall be NEMA type as shown on the drawings. Where NEMA type enclosures are not shown on the drawings, provide NEMA type most suitable for the environmental conditions where the motor starter is being installed.
- L. Enclosures shall be thoroughly cleaned, given a rust-inhibiting primer coat, and painted with manufacturer's standard colors.
- M. Provide nameplates for each control device on door in accordance with Section 16010.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install per manufacturer's and NEC requirements.
- B. Ensure National Electrical Code clearances.
- C. Verify proper overload heater and fuse sizes and replace/adjust if required.
- D. Adjust all motor circuit protectors per manufacture's recommendations.
- E. Test all control and safety devices to ensure proper operation.

END OF SECTION

SECTION 16484

VARIABLE FREQUENCY DRIVE (VFD)

PART 1 – GENERAL

1.1 SCOPE

- A. The work of this section consists of furnishing a Variable Frequency Drive as specified herein and shown on the drawings. Any changes from this specification shall be submitted to the Owner's Representative in writing for approval a minimum of 14 days prior to bid.
- B. The supplier of the VFD must be factory authorized for component level warranty repair work.
- C. Factory trained service engineer shall be available for on-site breakdown service within 24 hours of notification at any location within the continental USA.

1.2 RELATED WORK

- A. Section 16010 Electrical System General Requirements
- B. Section 16030 Equipment Installation
- C. Section 16121 Low Voltage Copper Wire and Cable
- D. Section 16195 Identification
- E. Section 16450 Grounding

1.3 SUBMITTALS

- A. Submit manufacturer's product data in accordance with Section 01300 with control schematics including control devices operating in conjunction with the VFD.
- B. Wiring diagrams and Manufacturer's recommended spare parts list shall be included with the submittal.
- C. Dimensioned drawings with significant detail for locating conduit stub ups and field wiring.
- D. Installation and Maintenance manuals shall be shipped with the VFD and shall include detailed installation, start-up, and checkout procedures and adjustment and troubleshooting information.
- E. Submit evidence that the equipment will be provided with all specified controls, features, options and accessories.

- F. Submit certification that the equipment is designed and manufactured in conformance with all applicable codes and standards.
- G. Certified copies of test results shall be submitted for all tests specified in this section.
- H. The VFD will be certified as compatible with the pump motor.

1.4 SYSTEM HARMONIC DISTORTION STUDY

- A. The Contractor shall gather all data on the electric utility service, connected station loads and station operation. The Contractor shall verify transformer size, X/R ratio, available fault current and fault capacity.
- B. The Contractor shall prepare a harmonic distortion study to determine voltage and current harmonics at the point of connection. The study shall include various VFD speeds and load settings.
- C. The Contractor shall submit confirmation the VFD limits disturbances below 5% THD for voltage and below the current distortion established in IEEE – 519 Table 10.3.
- D. The “point of connection” shall be the line side of the breaker on the line side of the VFD.
- E. The System Harmonic Study result finding will be part of the submittal package.

1.5 CODES AND STANDARDS

- A. The VFD shall comply with the applicable requirements of the latest standards of ANSI, IEEE, NEMA, the NEC, and be UL/CSA listed.

1.6 WARRANTY

- A. The Contractor shall warranty the VFD in accordance with the general provisions of the contract for a period of no less than two years. This warranty period will start at the end of the commissioning of VFD's. The warranty will be placed in the name of the Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Allen-Bradley
- B. Square “D”

2.2 MOTOR DATA

A. The AC drive shall be designed to operate an electrical motor with a nameplate rating of Two (2) 10 horse power and Two (2) 30 horse power, 460V three phase, 1.15 service factor, 90% power factor and a 94% efficiency.

B. Driven System Data:

	<u>Quantity</u>	<u>RPM</u>	<u>Description</u>
1.	2 each – 10 HP	3600	Vertical Turbine Pump
2.	2 each - 30 HP	1800	Horizontal Split Case Pump

2.3 CONSTRUCTION

A. The VFD shall convert fixed utility voltage and frequency to variable voltage and frequency for AC motor speed control, adjustable from 1.0 to 60.0 HZ.

B. The VFD shall produce adjustable voltage and frequency via a two-step process. The first section shall utilize a three-phase diode bridge rectifier to convert AC to fixed voltage DC. The rectifier shall maintain AC line power factor at 95% or better, at any combination of speed or load, including both displacement and distortion components. The second section shall utilize a fifteen step Pulse Width Modulated inverter that converts the fixed potential DC into a variable voltage, variable frequency AC waveform suitable for a standard three phase induction motor. VFD techniques other than pulse width modulated (PWM) technology will not be considered. The Contractor shall be responsible for ensuring compatibility of the VFD with the actual pump motor NEMA design.

The VFD will be a 18 Pulse system.

C. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section. Bipolar Junction Transistors, GTOs or SCRs will not be acceptable.

D. The amp rating of the transistors used in each phase of the inverter section shall be rated a minimum of 2.75 times the continuous amp rating of the VFD.

E. Full load efficiency shall be in excess of 95% at rated output frequency. Efficiency shall exceed 80% at 50% speed and load.

F. The adjustable frequency and voltage output shall provide constant volts per hertz excitation to the motor terminals, up to (60 HZ). The rated continuous output current of the VFD shall not be less than 1.10 times the full load amp rating of the motor to which the VFD is applied.

G. The logic section of the VFD shall be microprocessor based. In addition, VFD shall have a common logic card throughout the HP range required. Logic card, or control board, must be interchangeable. Logic card shall be a surface mounted device with a protective coating.

H. All parts and sub-assemblies shall be completely front accessible and easily removable. All printed circuit board connectors must be polarized and stamped with identifiers to match up with printed circuit board designators.

- I. For safety purpose, local operator control interfaces shall be 120 VAC or less.
- J. VFD shall accept speed reference inputs for 4 to 20 mA, 250 ohms input impedance. Input reference offset and gain shall be programmable to interface with a variety of transducers. Input A/D converter should be a least 10 bit to ensure smooth control of the output frequency.
- K. Digital Operator/keypad shall be included for monitor indication and ease of troubleshooting. Unit must be visible through the cover of the VFD. Digital Operator shall include the following minimum functions:
 - 1. Motor speed indication in RPM, percent speed, or other engineering units, selectable and scalable through software programming of the VFD.
 - 2. Speed Reference Signal.
 - 3. Fault trip annunciation.
 - 4. Output current accurate to within approximately 3% regardless of frequency.
 - 5. Output Power in kW.
 - 6. Output Voltage.
 - 7. Bus Voltage.
 - 8. The keypad operator shall display in text programmable in English or Spanish language for ease of understanding for the operators. The alphanumeric display shall be a minimum of 56 characters. Coded non-text displays or LED indicators are not acceptable.
- L. The VFD shall have a form C "Fault" contacts rated at least 1.0A, at 250 VAC available for customer use.
- M. The VFD shall have a normally open "Run" contact rated at least 1.0A, at 250 VAC available for customer use.
- N. All contact/switch inputs into the VFD must be completely isolated from the analog reference signal.
- O. A three phase input line reactor shall be supplied with the VFD.
- P. VFD shall be provided with RFI filtering.
- Q. Total voltage harmonic distortion, THD shall be a maximum of 5% measured at the point of connection.
- R. Total current harmonic distortion shall not exceed the values in Table 10.3 of IEEE – 519 at the point of connection.
- S. The VFD will be supplied with enough I/O expansion card to handle all the required signals and alarms as shown on the drawings.

2.4 OPERATING CONDITIONS

- A. Conditions of operation shall include:
1. Service factor for current capacity of 1.0 with 120% overload capacity for 60 seconds at maximum ambient temperature.
 2. Incoming three phase, 480VAC power, + 5% - 10% from nominal, 60 HZ.
 3. AC line frequency variation less than +/- 2% from nominal.
 4. Operating temperature range from +14 to +103 degree Fahrenheit. Contractor shall provide all necessary auxiliary equipment required for continuous operation within this temperature range. If auxiliary cooling, i.e. air conditioning is required, calculations showing proper size unit required to maintain temperature at specified limits at 100% load must be submitted.
 - a. Storage temperature range from -4 to 140 degree Fahrenheit.
 - b. Humidity rating of 90% RH, non-condensing.
 - c. Altitude of 3,300 feet or less.

2.5 PERFORMANCE/OPERATION

- A. Three-phase power applied to the motor shall be real time generated sine-coded Pulse Width Modulated to maximize available torque per amp and minimize unnecessary motor heating. In addition, waveform must be generated by an asynchronous carrier to eliminate torque pulsation and eliminate the irritation of "gear-shift" type audible noise fluctuations as the motor speed is varied.
- B. Output voltage fluctuations due to input voltage variations shall be eliminated by utilization of a voltage regulation scheme. Regulation must be at least +/- 3%.
- C. VFD must be able to start into a rotating load. Unit should perform "speed search" type operation in which the VFD will automatically decrease the output frequency to track motor speed. Once the VFD output is precisely matched to the motor RPM, the unit will smoothly return the motor to the speed set point at full rated motor torque, according to the programmed acceleration ramp. Units that trip or attempt to brake the motor by regenerative current limit will be unacceptable.
- D. 2.0 second power loss ride through capability. In the event of a complete loss (2 sec. and less) and restoration of three phase input power, the unit shall continue operation without requiring any fault reset. This feature shall be defeatable in the programming.
- E. VFD shall have user selectable capability to automatically apply a programmable level of regulated DC Injection current to the motor windings at start (anti-wind milling protection to bring the motor to rest when the direction of rotation can not be guaranteed) or stop. Non-regulated DC current (or voltage) control schemes are unacceptable. In addition, time at start and stop should be independently adjustable to provide application flexibility.
- F. Prohibited frequency points: The VFD must possess three field programmable, critical frequency rejection points with field programmable dead band.

- G. VFD shall have provision for user selectable reference loss protection. In the event the speed reference signal to the VFD decreases by more than 90% in less than 0.4 sec. the inverter shall continue operation at 80% of the previous setting. If the reference returns, the VFD will again track the input reference. The VFD shall stop whenever a stop command is given.
- H. Intelligent automatic fault reset. If the VFD experiences a non-catastrophic fault trip (not indicative of component failure), the unit will automatically reset the trip condition (field programmable number of restarts). After 10 minutes of continuous operation, the number of resets in the register shall be returned to zero.
- I. VFD shall have provisions to invert speed reference signal. As reference signal increases, output frequency decreases.
- J. Motor speed dependent, adaptive, motor thermal overload protection shall be programmable in the drive software based on motor nameplate amps.
- K. Standard programming adjustments via the English/Spanish language operator (switches and pot settings are not acceptable) shall include:
 - 1. V/Hz pattern
 - 2. Minimum Speed
 - 3. Maximum Speed
 - 4. Critical frequency rejection points
 - 5. Slip compensation
 - 6. Acceleration Time
 - 7. Deceleration Time
 - 8. Power loss ride through time
 - 9. Separately adjustable Current Limit for acceleration and at speed conditions.
 - 10. Motor thermal overload protection.
 - 11. DC Injection Time and Current.
 - 12. Motor Rated Current (for overload protection).
 - 13. Minimum MTBF shall be 100,000 hours.

2.6 PROTECTIVE FEATURES/FUNCTIONS

- A. Controller shall have as a minimum, the following alphanumeric fault trip indications annunciated in English or Spanish on the keypad operator. In addition, the fault diagnostics should be stored in non-volatile memory to retain important trip information after removal and later restoration of three-phase input power.

1. Over current (OC)
2. Over voltage (OV)
3. Blown Fuse (FU)
4. Overheat (OH)
5. Motor Overload (OL1)
6. Inverter Overload (OL2)
7. Phase Balance (PB)
8. Under voltage (UV)
9. External Fault Input (EB)

B. In addition, the following conditions must be detected or protected against:

1. Ground fault
2. Loss of phase
3. Output short circuit, phase-to-phase or phase-to-ground

2.7 PRE-ENGINEERED OPTIONS

A. The following integrally mounted options shall be provided with the VFD:

1. Proportional Integral Derivative, (PID) EEPROM controller. All control variables including reset; derivative times and proportional band shall be adjustable from the cover-mounted keypad. The PID controller shall accept a 4-20mA signal from an external pressure transducer.
2. Circuit breaker with through door handle, lockable in the "off" position. Unit shall have an AIC rating as indicated on the drawings. AIC rating shall be 65,000 A/C.
3. Drive shall be provided with standard RS-232C serial communications port, USB port and Ethernet communication.
4. AC Input Reactor
5. 6 digit non-resettable elapsed time meter, ETM.
6. Door mounted H-O-A selector switch. The drive will have Local and Automatic capabilities. Refer to Instrumentation and Controls drawings for further details.

2.8 QUALITY ASSURANCE

- A. 100% of the power semi-conductors (IGB transistors, diodes, etc.) must be inspected before acceptance.
- B. 100% of all completed printed circuit board assemblies must be subjected to a minimum 72 hour heat cycle, consisting of 9 cycles, each as described below:
 - 1. Raise temperature from ambient to +70 degree C in 0.5 hours.
 - 2. Maintain at +70 degree C for 3 hours.
 - 3. Decrease temperature to -10 degree C in 1 hour.
 - 4. Maintain at -10 degree C for 3 hours.
 - 5. Increase temperature to ambient in 0.5 hours.
- C. All printed circuit boards shall be subjected to a computerized functional test to verify the integrity of all components and circuits.
- D. Completed inverter must be subjected to full load testing prior to final inspection and shipment.

2.9 SERVICE

- A. The VFD manufacturer shall provide, at no additional cost to the Owner, a start-up package for the VFD. Service shall include inspection, final adjustments, operational checks and a final report for inclusion in the documentation package shipped with the unit.
- B. Factory trained service engineer must be available for breakdown service at the site within 24 hours of notification.
- C. VFD supplier must be factory authorized to perform warranty field and bench repair service. Such service must be performed at the component level to minimize any non-warranty repair charges to the Owner of the equipment. "Board Swapping" level of repair capability shall be considered unacceptable.
- D. Full remote analysis of the VFD shall be achievable with the motor leads disconnected from the VFD.

2.10 ENCLOSURE

- A. The VFD shall be installed within NEMA 12 enclosure.

PART 3 – EXECUTION

3.1 INSTALLATION AND START-UP

- A. A qualified manufacturer's technical representative shall supervise the contractor's installation, testing, and start-up. A minimum of 2 supervision days (16 hours) shall be provided by the manufacturer's representative.

3.2 SPARE PARTS

- A. Furnish spare parts for each drive as follows:
 - 1. All parts recommended by the Manufacturer as spare parts.
 - 2. Special tools as recommended by the manufacturer.
- B. All spare parts shall be packaged in original factory containers and labeled identifying all parts for recording.
- C. All spare parts shall be delivered to the OWNER after completion of work and prior to final acceptance.

END OF SECTION

SECTION 16485

ENCLOSED CONTACTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General purpose contactors.
- B. Lighting contactors.

1.2 REFERENCES

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the requirements of Section 16010, enclosed contactors shall comply with the following:
 - 1. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
 - 2. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Provide dimensions, size, voltage ratings and current ratings.
- C. Include manufacturer's installation instructions.
- D. Provide record drawings in accordance with Section 16010 and Section 01780, Closeout Submittals. Record the actual locations of each contactor and indicate circuits controlled on project record documents.

1.4 QUALIFICATIONS

- A. Manufacturer shall be a company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.5 REGULATORY REQUIREMENTS

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. Conform to requirements of NFPA 70.
- C. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE CONTACTORS

- A. Manufacturers:
 - 1. Square D Company.
 - 2. General Electric.
 - 3. ASCO.
- B. Description: NEMA ICS 2, AC general purpose magnetic contactor.
- C. Coil Voltage: 120 volts, 60 Hertz unless otherwise noted.
- D. Poles: As indicated.
- E. Size: As indicated.
- F. Enclosure: ANSI/NEMA ICS 6, Type 1/12 for indoor installation and type 3R for outdoor installation.
- G. Accessories: As shown.

2.2 LIGHTING CONTACTORS

- A. Manufacturers:
 - 1. Square D Company.
 - 2. General Electric.
 - 3. ASCO.
- B. Description: NEMA ICS 2, magnetic lighting contactor.
- C. Configuration: Electrically held 2 wire control.
- D. Coil Voltage: 120 volts, 60 Hertz unless otherwise noted.
- E. Poles: As indicated.
- F. Contact Rating: As indicated.
- G. Enclosure: ANSI/NEMA ICS 6, Type 1/12 for indoor installation and type 3R for outdoor installation.
- H. Accessories: As shown.

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 16700

TELECOMMUNICATIONS STRUCTURED CABLING SYSTEMS (ETHERNET/DEVICNET)

PART 1 – GENERAL

1.1 SCOPE

- A. This section generally describes the work and equipment required to furnish and install a complete commercial telecommunications cabling and pathway system with equipment rooms, telecommunications closets, backbone cable and pathways, cross-connect fields, patch panels, horizontal cabling and pathways, workstation faceplates, and testing. All active telephone or data network equipment shall be furnished and installed by the Owner, or under other sections of these Specifications.

1.2 RELATED SECTIONS

- A. Section 16010, Electrical System General Requirements
- B. Section 16030, Equipment Installation
- C. Section 16111, Metallic Conduit and Fittings
- D. Section 16121, Low Voltage Copper Wire and Cable
- E. Section 16190, Supports and Fasteners
- F. Section 16195, Identification
- G. Section 16440, Disconnect Switches
- H. Section 16450, Grounding
- I. Section 16475, Molded Case Circuit Breakers

1.3 REFERENCE STANDARDS

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, comply with the following standards:
 - 1. 16010ANSI/TIA/EIA-568-A, Commercial Building Telecommunication Cabling Standard.
 - 2. ANSI/TIA/EIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3. ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
 - 4. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

5. TIA/EIA TSB-67, Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.
6. UL 444, Standard for Communications Cable

1.4 QUALIFICATIONS

- A. The telecommunications structured cabling system installer shall be a company regularly engaged in furnishing and installing telecommunications cabling systems, and shall have completed a minimum of five projects of similar design and complexity within the last two years. Pathways may be installed by non-specialized electricians, but shall be under the direction of the telecommunications system installer.
- B. The telecommunications systems installer shall employ a system designer, who shall supervise all phases of planning, documenting, installing and testing of the telecommunications system. The system designer shall be BICSI certified as an RCDD, or shall have comparable certification from other industry recognized third party organization. The installer shall also provide a jobsite foreman with certification by BICSI as Cable Installer, or certification by the manufacturer of the specific cable being furnished, and shall be on site to supervise the installation crew at any time that installation or termination activities are underway.
- C. The optical fiber installation portion of this project shall be installed and terminated by a specialty contractor who is qualified for installation of blown fiber systems and certified by the cable manufacturer as meeting the terms of the manufacturer's warranty. A certified installer shall be on site to supervise the installation crew at any time that installation or termination activities are underway.

1.5 SUBMITTALS

- A. Provide submittals according to requirements of Section 01330, Submittal Procedures for the following:
 1. Submit statement of qualifications, listing project references to verify required experience, and proof of certifications for system designer and cable installer.
 2. Submit complete shop drawings showing layout of telecommunications spaces and pathways in plan view at no less than 1/8-inch scale. Submit scaled elevation sketches showing the arrangement of pathways, hardware and cable management in telecommunications spaces. Submit schematic diagram of cabling installation. Indicate labeling scheme for spaces, pathways, cables and connection hardware.
 3. Submit product data on all pathway components, cable types, and termination and cross-connect hardware.
 4. Review provisions in the building design for the telecommunications infrastructure and submit an itemized list of any building features which will keep the installation from being fully ANSI/TIA/EIA standards compliant.

5. Submit a plan of proposed test procedures and test reports; Indicate testing methods, testing device calibration, and interpretations of test results for field acceptance tests. The Owner's representative must approve all test plans before testing may begin. Final test plans shall be delivered no less than two weeks prior to the start of the first test.
6. Submit complete test data following acceptance testing of completed cabling links. Furnish test results in printed bound volume, and in electronic format capable of being imported into standard commercial spreadsheet and database management software.

1.6 WARRANTIES

- A. Warranty documentation shall comply with the requirements of Section 01780, Closeout Submittals.

PART 2 – PRODUCTS

2.1 PATHWAYS

- A. Underground conduits shall be Schedule 80 PVC (non-encased). All bends and risers shall be long radius rigid galvanized steel, suitable for installation of communications cable. Concrete encasement shall be minimum 2,000 psi concrete. All locating tape shall have metallic foil core.
- B. Interior conduits shall be rigid galvanized steel (RGS) meeting all requirements of Section 16111, Metallic Conduit and Fittings. Minimum conduit size shall be 3/4 inch. All bends shall be long radius, suitable for installation of communications cables.
- C. J-hooks shall be designed specifically to support telecommunications cabling of the type used in this project.
- D. Outlet boxes shall be minimum 4-11/16" square x 2-1/8" deep with single or two-gang plaster ring as required.

2.2 CABLES

- A. Interior backbone voice riser cable shall be 25-pair, 24 AWG, 100-Ohm, Category 5 UTP, with polyolefin insulation and flame-retardant PVC jacket, Berk-Tek Power Sum or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums. Provide quantity of cables as indicated on the plans. ANSI/TIA/EIA-568-B.2 Category 5 Backbone.
- B. Horizontal voice station cable shall be four-pair, 24 AWG, 100-Ohm, Enhanced Category 5E (350 MHz) UTP, with polyolefin insulation and flame-retardant PVC jacket, Berk-Tek Landmark-100, or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums. ANSI/TIA/EIA-568-B.2 Category 5E.
- C. Horizontal data station cable shall be four-pair, 24 AWG, 100-Ohm, Category 6 (500 MHz) UTP, with polyolefin insulation and flame-retardant PVC jacket, Berk-Tek Landmark-1000,

or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums. ANSI/TIA/EIA-568-B.2 Category 6.

- D. Provide tube cable system for installation of blown fiber bundles, FutureFlex manufactured by Sumitomo Electric, or approved equal. Provide Outdoor/All-Dielectric cables for outdoor (damp) use, comprised of seven tubes wrapped with water blocking tape and polyethylene outer jacket. Provide Indoor/Plenum Rated cables where routed through air handling plenums, comprised of seven single fire and smoke retardant tubes enclosed in an Aramid skip-binder with no jacket. Provide tube distribution units (TDU's) at each telecommunications closet, and other locations where splices or redirections of tubes are required.
- E. Optical fibers shall be multi-mode 50/100 combined in bundles. FutureFlex manufactured by Sumitomo Electric, or approved equal, with quantity of strands as indicated on the plans, for blown-in installation in tube cable. Cables shall have appropriate jacket rating for the application and environment.
- F. Provide color coding of station cable jackets so as to readily distinguish between data and voice cables, and between field cables of various other low voltage systems, such as EMCS, CCTV, clocks, etc.

2.3 CONNECTING HARDWARE

- A. Equipment mounting backboards in telecommunications closets shall be 4' x 8' x 3/4" AC plywood, painted all sides with two coats of fire-retardant white paint, and mounted to the wall in the vertical orientation with "A" side facing into room.
- B. Equipment racks shall be black, 7' tall, 19" wide, conforming to EIA standards, complete with Panduit FMPVS45, or equal, vertical wire management, and Panduit WMP1, or equal, horizontal wire management. Secure rack to floor and wall with angle brackets and black ladder rack of PFT model PFT-LR1012J, or equal.
- C. Terminal blocks for voice backbone and horizontal voice station cables shall be Category 5E, type 110 wire termination units consisting of insulation displacement connectors mounted in plastic blocks, frames or housings. Blocks shall contain cable management hardware. Blocks shall be 19" rack mounted as indicated on the plans. Terminal blocks shall be Panduit "Pan-Punch" series or approved equal, model P110B100R4WJ, with P110CB4 connecting blocks for station cables, and P110CB5 connecting blocks for riser cables.
- D. Patch panels for termination of horizontal data station cable shall be 19" rack mounted, Category 6, consisting of front access 8-pin modular jacks in a jack-to-jack configuration. Patch panels shall include cable management hardware and shall be Panduit "Mini-Com" CP48BL, or approved equal.
- E. Telecommunications outlet faceplates shall be as manufactured by Panduit or approved equal and shall be of the same material and finish as specified for electrical device coverplates under Section 16140, Wiring Devices. Faceplates shall contain the indicated quantity of eight-pin modular jacks. Jacks for data shall be blue in color and rated as

Category 6. Jacks for voice shall be ivory, and rated Category 5E. Provide blank inserts for spare ports.

1. Combination voice/data locations shall have a four-position faceplate with two jacks installed. The top (or left) jack shall be "voice." The bottom (or right) position shall be "data." The two center ports shall be spare.
2. Voice only, or data only, locations shall have a four-position faceplate with a single eight-pin modular jack in the top (or left) position. The other three ports shall be spare.

2.4 GROUNDING

- A. Telecommunications grounding busbars shall be a solid copper bar 1/4 inch thick, 2 inches wide, and 24 inches long, drilled and tapped, and fitted with provisions for connecting compression fittings of the quantity and size required for the installation. The ground bus shall be mounted to the plywood backboard or wall surface at 6 inches above the floor, oriented horizontally, and attached using 1-inch insulated stand-offs.
- B. The telecommunications grounding system shall use #6 AWG insulated copper conductor between each busbar within a closet, and to the nearest accessible point of the telecommunications grounding system. The telecommunications grounding system shall be bonded to the electrical grounding electrode system with with #6 AWG bare copper conductor.

PART 3 – EXECUTION

3.1 TELECOMMUNICATIONS SPACES

- A. Provide equipment rooms and telecommunications closets as indicated on the plans. Layout of pathways, cross-connect fields, equipment racks, grounding busbars and power receptacles on the plans are diagrammatic in nature. The telecommunications system installer shall arrange the spaces to comply with TIA/EIA standards and requirements of the project. Reserve any spaces identified on the plans for Owner's active equipment, and coordinate with the Owner prior to rearranging layout.
- B. All cables in telecommunications closets shall be neatly dressed down and terminated with wire management devices for cable routing.
- C. Patch cords shall be supplied by the Contractor.

3.2 PATHWAYS

- A. Provide conduits where indicated on plans. Provide pathways above accessible ceilings with J-hooks where cable tray or conduit is not used. All conduit, cable tray and J-hook pathways shall be routed parallel and perpendicular to building orientation. Diagonal runs will not be permitted.
- B. Provide continuous metallic conduit to enclose backbone cable from enclosure to enclosure for all of the route.

- C. Provide continuous metallic conduit to enclose horizontal cable from outlet backbox to accessible ceiling space, and above hard ceilings. Route cable through cable tray where available. J-hooks may be used above accessible ceiling space, at intervals not to exceed 5 feet. No cable shall be permitted to rest on structural elements, ceiling grids or other building components. Where metallic conduit is extended to cable tray, the conduit shall be securely clamped to the cable tray with a grounding clamp, or a grounding jumper shall be installed between the conduit and the cable tray.
- D. Provide conduit fitting with insulated throat at each conduit end.
- E. Provide pull cord in each conduit and/or innerduct, whether containing cables or spare.

3.3 CABLES

- A. Install all cables per ANSI/TIA/EIA-568-A, and manufacturer's installation and termination instructions. Provide cable management hardware and riser supports as required. Do not exceed allowable pulling tension.

3.4 CONNECTION HARDWARE

- A. Terminate all installed cable. Terminate to rack mounted type 110 terminal blocks for voice cables, patch panels for data cables, and fiber shelves for fiber optic cable as indicated on the plans.

3.5 GROUNDING

- A. Provide grounding and bonding per ANSI/TIA/EIA 607. Provide a minimum of one telecommunications ground busbar in each space or closet, bonded together and to the building electric service grounding electrode system with 6 AWG copper.

3.6 ADMINISTRATION

- A. Implement a component identification and labeling scheme as defined by the Owner, in compliance with ANSI/TIA/EIA 606. Label each cable and pathway end. Provide labeling and color coding of termination and cross-connect fields.
- B. Cables shall be marked as follows:
 - 1. Termination points inside the telecommunications closet shall be marked with location of the opposite end of the cable, either station outlet location, or in the case of backbone cable, the location of the other telecommunications closet, and the position of the termination within the closet.
 - 2. Termination points outside the telecommunications closets shall be labeled with the location of the telecommunications closet of origin, and the position of the termination within the closet.
 - 3. Cables shall be Labeled with Shrink Tubing before termination
 - a. Tubing will be of heat shrink type
 - b. Shrink tubing will be type printed only

- c. Locations designations shall be coordinated with the Owner at the time of installation.
- C. Contractor shall supply a list of all cable installed, by designation, along with the name of the installation supervisor onsite during installation and during termination.

3.7 TESTING

- A. Provide testing of each installed cable link per ANSI/TIA/EIA-568-A, and TIA/EIA-67.
- B. All testing results will show cable label, termination location and position within the telecommunications closet, and fiber strand or copper pair identification.

END OF SECTION

SECTION 17010

INSTRUMENTATION GENERAL CONDITIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section covers items common to sections of Division 17 Process Integration. This section supplements the requirements of Division 1. Division 1 shall be used to clarify any anomalies associated with sections of Division 17.
- B. The Contractor shall take full responsibility for and shall coordinate the work of Division 15 and Division 16 to guarantee a complete and finished installation of the electrical and instrumentation and control systems. The Division 17 drawings and specifications are to be read together with drawings and specifications of all other Divisions and specifically Division 16. Additional information necessary to complete the work is included in other sections of the drawings and specifications.

1.2 RELATED SECTIONS

- A. Section 17015, I&C Scope of work
- B. Section 17800, Acceptance Testing and Calibration
- C. Section 17810, Commissioning and Start-up

1.3 REFERENCES

- A. Codes and Standards: this Division of Specifications contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this Division and those of the listed documents, the requirements of this section shall prevail.
 - 1. NEC-08, 2008 National Electrical Code
 - 2. ASTM B68-86, Seamless Copper Tube
 - 3. ASTM D883-89, Terms Relating to Plastics
 - 4. IEC 61508, Functional Safety of Electrical Safety-Related Systems
 - 5. ISA RP7.1-56, Pneumatic Control Circuit Pressure Test
 - 6. ISA S5.4-76, Instrument Loop Diagrams
 - 7. ISA S51.1-79, Process Instrumentation Terminology
 - 8. ISA-S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
 - 9. ISA S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

10. ISA RP12.6-87, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
11. NEMA 250-2008, Enclosures for Industrial Controls and Systems
12. NEMA ICS 1-88, General Standards for Industrial Control and Systems
13. NEMA ICS 2-88, Industrial Control Devices, Controllers, and Assemblies
14. NEMA 70E, Test Methods for Electrical Wires and Cables
15. SAMA PMC 17-10-63, Bushings and Wells for Temperature Sensing Elements
16. UL 1012-89, Power Supplies
17. UL 508, Standards for Industrial Control Equipment
18. Weik, Martin H., Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983.
19. ANSI/EIA/TIA568A, Commercial building Telecommunications wiring standard and all the Telecommunications Bulletin Boards (TSBs) and Addenda issued by the above standard body at the time of bid.
20. ANSI/EIA/TIA-568.B.2.1 Commercial Building Telecommunications Cabling Standard Part 2 (Including latest issue of TSB36 SSTB40).
21. Building Industry Consulting International (BICSI) TDMM Manual 10TH edition.
22. Building Industry Consulting International (BICSI) Network and LAN Design Manual 4th edition.

B. Instrumentation and Control Qualifications

1. The Contractor responsible for Instrumentation & Controls work shall be trained and conversant with control integration and instrumentation required for this project. The Contractors shall attach a copy of the certifications and proof of their belonging with a certified installer program from the manufacturer along with their submissions. The installing / integrator Contractor shall have at least five years experience in the PLC – controls industry and at least five similar installation projects in South-East Michigan with the system proposed for the project. Please refer to Section 17015 for system integrator requirements.
2. The Contractor shall provide fully qualified journeyman instrumentation and electrical personnel capable of performing the requirements of this work. The work identified in this Contract also includes installation; testing, configuring, verification and commissioning of DeviceNet and Ethernet based components of electrical and instrumentation and control systems. The qualifications of the instrumentation personnel shall include adequate and appropriate training in communications technology.
3. The Contractor shall provide evidence of suitability to complete the scope of work under this contract, e.g., similar completed projects, key project personnel resumes, certificate of recognition at the request of Engineer.

1.4 GLOSSARY OF TERMS

A. An explanation of definitions used throughout Division 17 are as follows:

AI/AO	Analog Input / Output
CDACS	Computer and Data Acquisition Control System; see SCADA
DI/DO	Digital Input / Output
FAT	Factory Acceptance Testing
EDS	Electronic Data Sheet
EIA	Electronic Industries Association
EMI	Electromagnetic Interference
GUI	Graphical User Interface
HMI	Human Machine Interface – an industrial computer panel or operator interface terminal usually installed outside of a control area, which allows viewing of various process area real-time graphics, viewing alarms, changing of process parameters and modes and other operator control actions. The functionality of MI is independent of the SCADA computer (servers / clients).
I/O	Input / Output Signals
ILD	Instrument Loop Diagram
ISA	International Society of Automation
LAN	Local Area Network
MCC	Motor Control Center
MTBF	Mean Time Between Failures
MOV	Motor Operated Valve
OEM	Original Equipment Manufacturer
OIT	Operator Interface Terminal
OPC	OLE for Process Control (communication interface driver)
PC	Personal Computer
PCS	Plant Control System – all automatic process control components including SCADA / PLC, standalone controllers, Operator Interface Terminal, etc. Same as SCADA.
PICS	Process Instrumentation and Control System

PID	Proportional, Integral, Derivative Process Control Actions
PLC	Programmable Logic Controller
RAM	Random Access Memory
RFI	Radio Frequency Interference
SAT	Site Acceptance Testing
SCADA	Supervisory Control and Data Acquisition (also referred to in this context as PCS). A SCADA system includes controllers, processors, networks, SCADA computers, computer software user interface (SCADA software), communication equipment and communication protocol. A SCADA system monitors the entire plant process in real time.
UL	US Underwriters Laboratory
UPS	Uninterruptible Power Supply
WAN	Wide Area Network
WTP	Water Treatment Plant

- B. FIELD WIRING: Shall mean all labor and material necessary to connect all instrumentation and control devices and equipment, both discrete and analog, regardless of voltage and current, and all associated power supply wiring and shall also include all interconnecting cables between portions of the system.
- C. COMMUNICATION WIRING: Shall mean all work and material required for connection of control data communications including but not limited to Ethernet, BACNet, DeviceNet and Modbus communications.
- D. Interpret specialized terms not explicitly defined herein in accordance with ISA S51.1, NEMA ICS 1, ANSI/IEEE Std 100, and The Communications Standard Dictionary, by Martin H. Weik.

1.5 REQUIREMENTS OF WORK

- A. The Contractor shall be ultimately responsible and shall provide for the supply, installation, certification, adjustment, tuning and start-up and commissioning of a complete, coordinated system that shall reliably perform the intended functions.
- B. The Work includes all hardware, labor and services necessary to provide fully functional, coordinated control system for the Chiller Electrical Systems. Supply all items and accessories specified by the Contract Drawings or the specification in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labor and incidentals.
- C. Codes, Rules, Permits & Fees.
 - 1. Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.

2. Comply with all rules of the Electrical Safety Act of the State, National Electrical Code, US Underwriters Laboratories and applicable Building Codes, whether specifically shown on drawings or not, relating to supply of products and installation quality.
- D. Refer to Section 17015 for basic of the scope of instrumentation and control work under this contract. Refer to all other drawings and specifications for the complete scope of the Instrumentation and Controls work.
- E. Where packaged, stand-alone control systems are supplied under other Divisions of this Contract, coordinate and ensure Submittal Drawings, Motor Control Schematics, Instrument Specification Sheets (ISS), and Control Wiring Drawings are provided in accordance with the requirements of this section and in accordance with the Division 17 Drawings.
- F. Where modifications are made to packaged systems, stand-alone control systems, or other Contractor equipment supplied under other Divisions of this Contract, and the modifications are due to vendor or Contractor changes to the systems in question, the systems may be considered acceptable provided:
1. The proposed system and/or its modifications satisfy the intent of the specifications.
 2. The changes or modifications combined for all aspects of work by all trades do not result in a cost addition to the Contract
 3. Approved by the Engineer.
- G. Where packaged, stand-alone equipment with control systems are supplied by other Divisions of this Contract, provide all necessary labor, material and cabling to install and connect the equipment to the required remote monitoring and/or control functions. Coordinate and provide all supplies to complete end-to-end commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other Divisions.
- H. The contract drawings for Division 17 detail the wiring requirements, cables, terminations, and Plant Control System (PCS) interface requirements for equipment and control systems contained within packaged systems supplied under other Divisions of this Contract or pre-purchased. These drawings have been produced to accurately show the control intent for the packaged system. If the packaged system provided differs from that shown on the drawings, or if modified terminations, cabling or interfaces are required to properly integrate the actual equipment to the process, electrical distribution, or PCS, the Contractor is to provide cables, wiring, and terminations to satisfy the general intent as per the drawings, at no additional cost to the Contract.
- I. The Contractor's responsibility also includes receiving, uncrating, examining for shortages or damage, assembling, field fitting, installing, mounting, wiring and testing of vendor supplied component subsystems.
- J. Subsystems of the instrumentation and control system will generally include the following:
1. Primary elements and transmitters;
 2. Final control elements;
 3. Instrumentation and control field devices;
 4. Instrumentation and associated power cabling;

5. Instrumentation power supplies;
 6. Communication wiring;
 7. Conduit and cable tray;
 8. Instrumentation and control junction boxes and marshalling panel;
 9. Plant Control System Hardware;
 10. Instrumentation and control local control panels with the associated equipment.
- K. Plant Control System (PCS) is the overall plant computer control. The PCS includes but is not limited to:
1. An existing SCADA Server located in the SCADA server cabinet in the Ozone Building control room.
 2. Two (2) HMI Panel located in each of the chiller enclosures (40 ton and 100 ton).
 3. Integration/connection into existing Ethernet Switches as necessary.
 4. Equipment cabinets and racks as detailed in drawings.
 5. Integration of Chiller Manufacture supplied Chiller PLCs (QTY. 2) control panels with power supplies, CPU and I/O panel racks as detailed on drawings:
 - a. PLC-CS #1 (Chiller Vendor PLC) – 40 Ton
 - b. PLC CS #2 (Chiller Vendor PLC) – 100 Ton
 6. Various Local Control Panels (LCP) equipment as detailed on drawings.
 7. Various Vendor supplied Control Panels (VCP) and instrumentation.
 8. Miscellaneous Controls and Instrumentation.
 9. HVAC Control Interface with Mechanical Equipment.
 10. Integration of communications for PLC-CS #1/#2 back to the plant via an existing Ethernet system.
 11. Integration of communications for Four (4) Variable Speed Drives (VFDs) for process and plant cooling water pumps back to the plant via an existing Ethernet system.
 - 12.
- L. All software, field devices, wiring and local control panels and system integration work not specifically defined as supplied by others shall be provided under this Contract.
- M. Compliance:
1. Failure to comply with the Drawings and Specifications shall be cause for rejection of the work and the Contractor shall be required to make all required changes to comply with the drawings and specifications at no additional cost to the Owner or

their agents and representatives.

2. Where a conflict exists between any applicable code, regulation, directives, standard or manufacturers recommended practice for any item and what is shown on drawings or specified, seek clarification from the Engineer prior to submitting Bid or allow for the most expensive alternative.
- N. Where packaged, stand-alone control systems are supplied under other divisions of this specification, provide cabling to connect to the required remote monitoring and/or control functions. Install and wire equipment and provide end-to-end commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other divisions of this specification. Integrator shall provide full system integration into the main plant SCADA system.
- O. Documentation provided by the Contractor shall meet overall requirements of Division 1 as well as the specific requirements detailed in each Section.
- P. Documentation provided to the Contractor by the Engineer includes the following:
1. P&ID's – depict the general intent of the control systems and are to be used as the governing document for the scope of work.
 2. Control System Architecture Drawing(s) – showing connection diagram between major I&C system components, including Ethernet Fibre & Cat 6 and DeviceNet or other Ethernet networks.
 3. Instrument & Input/Output Index – a sorted index of the detailed information, database and I/O points for the devices shown on the P&ID's. The index lists the appropriate support documentation for the devices' supply and installation. The instrument index is the controlling document for the supply of materials, it is the responsibility of this contract to update and maintain during approval and construction to date, to reflect the "As Built" condition.
 4. Instrument Specification Sheets (ISS) - detail the relevant data for the supply of devices.
 5. Typical Instrument Loop Diagrams (ILDs) – showing interconnections and hook-up of devices with conventional I/Os. The Contractor is responsible to reproduce an ILD for each device and record all relevant as-built information on each sheet for submission at the completion of the work. Fill in all terminal and wiring numbers etc. from the shop drawing as they become available. Typical examples are provided in the design drawings.
 6. Location Drawings – indicates in plan and/or elevation views where the instrument elements and any other control system components are physically located. These drawings are provided to assist the Contractor in locating the devices.
 7. Plant control system network topology drawing.
 8. Instrumentation single line diagrams, LCP schematics and general arrangement drawings.

1.6 COORDINATION

- A. Equipment provided under this Contract shall be installed by the Contractor and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are

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noted by the Engineer.

- B. The Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, connectors, wiring, and service conditions are appropriate; and that all devices necessary for a properly functioning system have been provided. Where specific hardware, materials or work is required to create fully compatible mounting and interconnection they shall be included in the Work without additional cost.
- C. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
- D. Approximate instrument locations are indicated on the Drawings. Exact instrument locations shall be coordinated with installed piping and equipment arrangements to provide adequate instrument access. In addition, proposed location shall be sign-off with the Owner personnel and the Engineer prior to install.

1.7 DOCUMENTATION

- A. Contract Drawings and Specifications
 - 1. Refer to General Conditions.
 - 2. Supply and install all items and accessories specified by the drawings or the specification in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labor and incidentals.
 - 3. Treat any item or subject omitted from this division's specifications or drawings, but which is mentioned or specified in other divisions' specifications or drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.
 - 4. Provide all minor items and work not shown or specified but which are reasonably necessary to complete the work.
 - 5. If discrepancies or omissions in the drawings or specifications are found, or if intent or meaning is not clear, consult the Engineer for clarification before submitting tender. If a ruling has not been requested, the Contractor shall allow in the tendered price for more expensive alternative.
 - 6. The responsibility to determine which division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.
- B. Submittals
 - 1. Submittals shall comply with the requirements of Specification Section 01330, Submittal Procedures. The list of equipment for which shop drawings are to be provided includes, but is not limited to:
 - a. Control Panels – Engineered shop drawings
 - b. Field Panels & Remote I/O Panels - Engineered shop drawings
 - c. Cable Junction Boxes – Engineered shop drawings

- d. Instrumentation Equipment – including instrument specification sheet for each device as per Section 17701
 - e. PLC Equipment – including all hardware and associated control panel assemblies details.
 - f. Terminal blocks
 - g. Communications, control & power cables
 - h. Relays
 - i. Terminal and Wire Marking System
 - j. All Ethernet Network Equipment
 - k. All Device Net and Fieldbus Network Equipment
 - l. Cat 6 and Fiber Cables and Patch Cords
 - m. Equipment Server cabinets and Racks
- C. Operations and Maintenance Manuals and As-Built Drawings
- 1. Submit O&M Manuals in accordance with the requirements of Section 01781, Operations and Maintenance Data.
 - 2. The Contractor shall submit an updated instrument index list with accurate loop drawings numbers for each instrument which has the associated loop drawing.
- D. Standards of Workmanship
- 1. Execute all work in a manner which will result in the completed installation presenting an acceptable appearance to a level of quality defined in the general conditions of this specification.
 - 2. Unless otherwise specified or shown, install products in accordance with the recommendations and ratings of the product manufacturers.
 - 3. Remove advertising labels from all products installed that have such labels attached. Identification or UL labels are not to be removed.
 - 4. Remove dirt, rubbish, grease, etc. resulting from work performed under this section of the Contract from all surfaces.

1.9 EQUIPMENT

- A. Receiving, Storing, and Protection of Components during Construction:
- 1. Examine each component upon delivery to site. Report all damage noted to the Engineer prior to accepting or rejecting delivery. All instrumentation primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building. Maintain the space temperature above 60° F and the space relative humidity below eighty (80%) percent.

2. Perform a preliminary examination upon delivery to ensure that all instrumentation and control components supplied for this project under this section of the specification comply with the requirements stated in the instrument specification sheets and drawings.
3. Itemize all non-conformities noted above and forward them to the Engineer. Any delays in construction resulting from the delivery to site of non-conforming instrumentation and control components to be the responsibility of the Contractor.
4. Precautions:
 - a. Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Engineer prior to installing any equipment of this type.
 - b. The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that, after installation, there are sufficient clearances on all sides for maintenance, servicing and operation of the equipment
 - c. Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.
5. Return all damaged equipment to the factory for total corrective repairs.

1.10 SITE

- A. Classification of Plant Areas
 1. Refer to Division 16.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The instrumentation and equipment shall be supplied with the individual instrument specifications and the Instrument Data Sheets. These Data Sheets shall be based on the input/output requirements of the chiller manufacturer's equipment.

2.2 TAGGING

- A. Each instrument and controlled device provided under this Section, whether specifically identified on Instrument Data Sheets or not, shall be provided with a permanent identification tag which agrees with the designation assigned by the Owner. Where primary elements and transmitters are physically separated, an identification tag for both devices shall be provided. All field-mounted elements and transmitters shall have stamped stainless steel identification tags. Panel, sub-panel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device.
- B. Identification tags shall contain tag numbers specifically assigned by the Owner during the Project.
- C. The Contractor shall provide tags for Owner supplied instruments unless otherwise noted.

- D. The Contractor shall submit to the Engineer and receive approval for the wording of all tags prior to fabrication.
- E. Identify all wires where they terminate at the marshalling panels, fibre optic patch panels, local control panels, junction boxes, and field devices with a heat shrink sleeve with machine printed labelling. Cat6 Ethernet, DeviceNet, Modbus cables, analog cables and wires, control cables and wires for digital inputs/outputs, 120VAC power cables and wires for local control panels and instruments shall be identified at both ends.
 - 1. Identify all wiring with permanent indelible numbered markings at each end of each cable and conductor with approved type wire markers. Submit proposed cable numbering for review by the Engineer and Owner before commencing the installation.
 - 2. The cable and wire numbering system shall be as per Section 16140. Color coding to NEC current edition unless otherwise indicated.
- F. Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature service.
- G. Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.
- H. Identify all exposed control conduits at all pull box locations, where the conduits enter or leave a location, and 30 feet on center throughout the location. This shall apply to conduits above removable ceilings.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

- A. Refer to the requirements of Division 1.

3.2 COORDINATION WITH OTHER DIVISIONS

- A. Examine the drawings and specifications of all divisions associated with this work and familiarize. Before commencing work, obtain a ruling from the Engineer on any conflicting issues between divisions.
- B. Provide work plan and identify methodologies for equipment installation with provision made for the most expeditious means to complete the work.
- C. Structural members shall not be cut without prior approval of the Engineer.

3.3 PRODUCT HANDLING

- A. Use all means necessary to protect the installation and to protect products and installed work of all other trades.
- B. Any damage to the products and/or installed work shall be repaired or replaced by the Contractor at no additional cost to the owner, and to the approval of the Engineer.

3.4 SEPARATION OF SERVICES

- A. Maintain separation between the electrical wiring system, building piping, ductwork and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.
- B. Classifications of Circuits:
1. The circuit categorization shall of first priority follow NEC code with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility and for determining necessary separations:

Very Noisy	High voltage circuits and their associated grounding
	High current (>200A) LV circuits
	Harmonic-rich LV circuits
	DC circuits: un-suppressed or above 50V
Noisy	Low current class 2 circuits Medium power pulsed or radio frequency circuits
Indifferent	ELV digital status circuits
	Intrinsically safe circuits
	Telecommunications circuits
	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits)
	Any other emergency, shutdown, or high integrity circuit (e.g., toxic gas alarm)
Sensitive	Analog signal circuits
	Data communication circuits
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors)

2. Separation of Circuits
 - a. This section relates to running cables carrying differing types of circuits in close proximity to one another and to other services. Sensitive circuits and very sensitive circuits shall normally be run in individually twisted pair shielded cable.
 - b. For cables sharing the same support / containment system, the following shall provide guidance to minimize extraneous interference.

3. Segregation details:

Segregation between circuits	Very Noisy	Noisy	Indifferent	Sensitive	Very Sensitive
Very Noisy	Thermal grouping as per NEC code	6 inches	12 inches	12 inches	12 inches
Noisy	6 inches	Thermal grouping as per NEC code	6 inches	6 inches	6 inches
Indifferent	12 inches	6 inches	Separation of circuit types	4 inches	4 inches
Sensitive	6 inches	6 inches	4 inches	Touching	2 inches
Very Sensitive	12 inches	6 inches	4 inches	2 inches	Touching

4. Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Engineer and the ceiling installer, and only if approved clips or hangers are used.

3.6 EQUIPMENT CONNECTIONS

- A. Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Engineer.
- B. All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different manufacturer's equipment. Verify all control circuits with the suppliers of the equipment and make any corrections to the control wiring diagrams that may be required.
- C. Provide power disconnect terminals in the marshalling panels for all devices or control system input/outputs sourced from the panel.
- D. Provide a disconnecting means in the cable connecting each ultrasonic transponder to the transmitter. This disconnect shall consist of a terminal strip in a local WP junction box with approximately 10 feet of cable from the transponder.

3.7 WIRING TO EQUIPMENT SUPPLIED BY OTHERS

- A. Equipment supplied by the Owner or by other Divisions, that have external or field mount control devices, is to be installed, wired and commissioned by this Division.

3.8 ACCESS PANELS

- A. Provide access panels where instrumentation and control system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners. The type and size of panels are to be coordinated with the Engineer.
- B. In removable ceiling areas provide markers on ceiling tile to locate equipment requiring access. Use a 1-inch dia. blue circle painted on the access panel to indicate that it is for instrumentation and control system access.

3.9 SEALING OF WALL AND FLOOR OPENINGS

- A. Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.
- B. Seal openings after all wiring entries have been completed.
- C. Sealing material shall be fire resistant and not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations, if required, are to be sealed. Acceptable methods are Canstrut "Fire Stop", Electrovert "Multi-Cable Transit" or Dow Corning RTV Silicone Foam.
- D. Cable transit blocks (with knock out blocks) are also acceptable as long as they have capability to be sealed.

3.10 SLEEVES

- A. Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- B. For wall, partitions and ceilings the sleeve ends are to be flush with the finish on both sides. For floors the ends shall extend 4-inches above finished floor level.
- C. Fill the space between the sleeve and the conduit with fire stop material and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.
- D. Locate the sleeves and position exactly prior to construction of the walls and floors.
- E. Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.11 INSTRUMENT MOUNTING STANDS

- A. All instrumentation and equipment furnished under this Section shall be provided with all required mounting hardware to mount the device according to the mounting requirements indicated in the individual device specification or the Instrument Data Sheet.
- B. Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminum or stainless steel.

- C. Supply and install protective drip shield for any exterior stand-mounted instrumentation equipment. The drip shield is to extend 2-inches at the top and sides from the front face of the equipment. The drip shield is to be fabricated from aluminum.

3.12 CONNECTIONS TO MECHANICAL, ELECTRICAL AND EXISTING SYSTEMS

- A. Refer to Divisions 15 and 16 for the required tie-in procedures.

3.13 CALIBRATION AND CONFIGURATION

- A. Refer to Section 17800, Acceptance Testing and Calibration, for instrument calibration requirements and procedures.

3.14 COMMISSIONING

- A. Refer to the requirements of Section 01810 and Section 17810 for commissioning requirements.

3.15 PROPER MOUNTING

- A. Follow the appropriate instrument installation standard details and manufacturers recommendations for installing local and field instrumentation and electrical devices.
- B. Do not install instrumentation on any support structures which could be removed e.g., process piping, plumbing, handrails. In general instruments shall only be installed on their own instrument support.

3.16 TRAINING

- A. Provide training and training literature, described in Section 01820, Demonstration and as described specifically for Instrumentation and Controls.

END OF SECTION

SECTION 17015

I&C SCOPE OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Plant Control System Description
 - 1. The system to be installed under this Contract is summarized on the Plant Control System (PCS) Architecture Schematic drawings.
 - 2. The equipment installed by the Contractor will include but not be limited to:
 - a. Local Control Panels – minimum of two (2) chiller panels
 - b. I/O Control Panels
 - c. Cat6 Ethernet wiring and communication equipment including: Industrial Ethernet, Modbus TCP and Ethernet / IP.
 - d. DeviceNet, Fieldbus and Modbus wiring and communication equipment.
 - e. Instrumentation associated field wiring and power supply wiring.
 - f. Integration of Variable Speed Drives between chiller controls (LCPs) and the Plant PCS system.
- B. Description of Process Area Control Equipment
 - 1. The P&ID drawings, Control System Architecture drawings, an instrument index in and PLC I/O list Section 17701 and typical instrument loop diagrams are included and describe most of the instrumentation signals, complete with their wiring requirements, to be connected as PCS I/O and communication ports. The Contractor shall take a detailed take-off from all drawings and specifications for an accurate list of instrumentation signals.
- C. Owner's Responsibilities Under This Contract
 - 1. Provide TCP/IP network scheme and assigned addresses.
 - 2. Addition of new chiller data into existing plant SCADA system.
 - 3. Programming of new signal wired to existing WTP PCS system. Programming of chiller LCP is still the responsibility of the CONTRACTOR.
- D. Work Under This Contract
 - 1. The Control System / Instrumentation work to be done under this Contract includes, but is not limited to, the supply of materials, labor, equipment, and permits necessary for the complete control system manufacturing, assembly, shop testing, installation, site testing and commissioning for the Chiller replacements, and associated equipment.

2. System Integration Qualifications:
 - a. The CONTRACTOR performing the work of Division 17 shall meet or exceed the following qualifications. Upon request by the ENGINEER and prior to award of the Contract, the CONTRACTOR shall be required to demonstrate compliance with the stated qualification requirements.
 - b. Organization that has been established for a minimum of 10 years and actively involved in the business of process control and instrumentation systems integration and has adequate plant facilities, organization structure, manpower, and technical and managerial expertise to properly perform the work under and in conformance with these specifications.
 - c. Involvement in 5 (minimum) projects of similar scope and size involving the design, integration, installation, testing and commissioning of water and wastewater treatment facility process instrumentation and control systems over five (5) years.
 - d. Shall have at the time of project advertisement an experienced engineering and technical staff capable of process control system design, integration, testing, and commissioning, as well as a thorough understanding of water treatment processes.
 - e. Shall have the in-house resource of permanent personnel for the preparation of system documentation and system operation and maintenance training. All instrumentation and industrial electronic systems shall be provided under the supervision of a single systems integrator, chosen by the CONTRACTOR, which is regularly engaged in the design and installation of such systems of similar scope and complexity.
 - f. CONTRACTOR shall have personnel located within a 4 hour response time of the project. CONTRACTOR shall also provide contract information directly to involved personnel once the process systems are functional.
 - g. The organization must have a direct formal relationship with the specified hardware manufactures. This relationship at a minimum shall include certification as a Rockwell Automation System Integrator and interfacing with manufacturer local controllers (Chillers).
 - h. The following CONTRACTORS have been pre-qualified for this project: Commerce Controls, Motor City Instrumentation and Controls, UIS Group of Companies and Windemuller.
 - i. Additional system integrations for will be approved if the criteria of 17015 D.2. a-h are documented and approved with the ENGINEER or Owner.
3. The work under this Instrumentation and Control (I&C) Section of the Contract includes supply of Instruments as specified in the Instrument Index and Instrument Specification Sheets (ISS) including those supplied with packaged equipment.
4. The CONTRACTOR shall solicit the services of a suitably qualified systems integrator, as their sub-contractor to provide the following control systems engineering:
 - a. Fully integrate the chiller manufacturer VCP into the plants SCADA platform.

- b. Supply of all PCS software programming necessary to provide a fully functional and coordinated control system for the chiller VCP. This will include the development of all necessary ladder logic programs and HMI graphics.
 - c. Workshops to develop ladder logic and HMI graphics.
 - d. Supply of Plant Control System Application Manual.
 - e. Supply all PCS related operators training.
 - f. Conduct testing of all communication interfaces.
 - g. Setup, test, and commission all communication equipment and parameters for all Ethernet, Device Network, and Ethernet IP devices.
 - h. Document and remark Modbus tables suitable integration to the existing Intellution iFIX SCADA systems.
 - i. All configuration and driver information is required to interface/extract Modbus data. CONTRACTOR is responsible to make the data available and usable.
5. Notwithstanding the responsibilities set out above, the general contractor shall retain overall responsibility of the complete electrical and instrumentation systems.
6. The General Contractor will review contract documents to determine the complete instrumentation, electrical, and data communications network requirements, and assemble a list of contract design information for clarification by the Engineer. The Contractor will be required to produce a work schedule in a compatible format with the Master Project Schedule, and submit it to the Engineer for approval. The submission task milestones will be compliant with the milestones of the Master Project Schedule.
- E. Related Work Shall Include But Not Be Limited To:
- 1. Electrical work - specified in the Electrical Sections under Division 16, shall be considered to be a part of these Specifications for proper coordination between the Control system and the Electrical portions of the Work. The Electrical system work (Divisions 16) shall be supplied under the General Contract. The Division 17 Contractor shall be under the Division 16 responsibility for purpose of contract coordination.
 - 2. Various Process Equipments will be supplied under separate divisions. The process Equipment shall be incorporated by the Contractor into the overall process control system at the Ann Arbor WTP. The Various Process Equipment will be installed on site by other divisions, and tied into the control system by this division.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17720 Computerized SCADA System
- D. 17800 Testing and Calibration for Instrumentation

- E. 17810 Commissioning Plan
- F. 17820 Personnel Training

1.3 WORK INCLUDED

- A. The Work included is the provision and commissioning of a complete and fully functional treatment facility with associated systems and plant control system. The work shall include any equipment, material and labor not specifically noted or detailed in the specifications and drawings but which is evidently required to furnish a complete system. The work shall include but not be limited to:
 - 1. Provide all instruments shown in the specifications and drawings, unless specifically noted as supplied by others, complete with their required installation and mounting supports and hardware, sunshields, field, communication and power supply wiring to the associated control panels, calibration, setup, testing, adjusting and commissioning. The Contractor shall coordinate with the General Contractor and Process system installer and all other divisions.
 - 2. Installation of all instruments shown as supplied by others, complete with all field, communication and power wiring to the associated Area and Vendor Control Panels, required installation and mounting supports and hardware, programming, setup, adjusting fine tuning, testing and commissioning.
 - 3. Provide engineered and complete Local Control Panels (LCP) as indicated in Section 17440. All required mounting hardware is to be supplied by the Contractor.
 - 4. Install Vendor Control Panels (VCP) provided by packaged equipment suppliers, others and the Owner as indicated in Section 17440. All required mounting hardware is to be supplied by the Contractor. Provide power supply and field wiring to all associated instruments. The vendor control panels supplied by others shall include but not be limited to:
 - a. Chiller System Panels.
 - 5. Wire and setup all electric, hydraulic & pneumatic valves, gates, and damper actuators and positioners.
 - 6. Provide setup and commission DeviceNet and Ethernet networks. Terminate both ends of each DeviceNet bus. The chillers and variable speed drives will be configured for a Ethernet topology.
 - 7. Provide calibration for all new installed sensors.
 - 8. Allow in the contract sufficient time to test, adjust, demonstrate and troubleshoot the complete control system including all devices and wiring. The Contractor shall have a fully qualified and available Control technician(s) to work totally independently or with the installed equipment representative until a complete control system is commissioned and works reliably and trouble free. The technician must be available and dedicated to the commissioning during all the time of the commissioning. The expected duration of commissioning is one man month.
 - 9. Notwithstanding item 8 above, allow time in the contract to work as directed by the Owners representative to make any changes and adjustments to final installed PCS system for one month after final commissioning.

10. The Contractor shall be fully qualified and equipped to carry out the testing of all control and instrumentation equipment and systems or as an alternative, shall provide the services of a qualified manufacturer's representative to carry out testing. Certified calibration certificates are required for all calibration equipment.
11. The Contractor will assume full responsibility for protection and safekeeping of all equipment supplied.
12. Preparation for Division 17 shop drawings to be submitted to the Engineer for review and approval as directed in Division 1.
13. FAT - Factory Acceptance Tests (at WTP Ozone building).
14. SAT - Site testing and site acceptance tests.
15. FAT and site testing will also be conducted by the Contractor to assess the quality of control system components and marshalling and local control panels.
16. Allow in the Contract for all work necessary to identify and tag wiring in process provided new packaged equipment as required to determine the correct points and connection procedures required to integrate the equipment into the new instrumentation and control systems. Where necessary, obtain and review schematic diagrams, wiring diagrams and operating and maintenance information for other divisions provided equipment to assure correct connection.
17. All seismic restraints for all I&C equipment and installations.
18. Provide as-built drawings.
19. The Contractor will make provision to participate in overall plant operations testing during plant start-up and full commissioning. They will respond to field instrumentation/data communications problems during this period and provide the necessary corrective action when required.
20. Following completion of the plant operations testing, the General Contractor to rectify any outstanding deficiencies.
21. The Contractor will also be required to provide Warranty Services Support during the maintenance period for the equipment applicable under its scope of responsibilities.
22. The Contractor will be responsible to properly identify and tag all items supplied sufficiently to prevent loss. Tagging will be of particular importance when the equipment is delivered to site. An equipment list will be made available to the Engineer following delivery to site.

1.4 WORK EXCLUDED

- A. General Requirements
 1. Not applicable.
- B. Other Work Excluded
 1. All wireways such as conduits, cable trays etc, provided by Division 16.
 2. Power supply to all Local and Vendor Control Panels (Provided by Division 16).

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3. Provision of all valves, gates, dampers complete with associated actuators – by Process/Mechanical (Division 11).

PART 2 - PRODUCTS

N/A

PART 3 - EXECUTION

N/A

END OF SECTION

SECTION 17114

INSTRUMENTATION AND CONTROL CABLES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Materials and installation of wires and cables.

1.2 RELATED SECTIONS

- A. Section 16122 - Wire and Cable - 0 - 1000 V.
- B. Section 16145 – Instrumentation Cable

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 SUBMITTALS

- A. Submit product data in accordance with Section 01330 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 TWISTED PAIR SHIELDED CABLES (TPSH)

- A. TPSH shall be constructed as follows:
 1. Two (2) copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 2 inches.
 2. Insulated for 600V, 180° F.
 3. One hundred (100%) percent coverage aluminum foil or tape shield.
 4. Separate bare stranded copper drain wire, minimum #18 AWG.
 5. Overall flame retardant PVC jacket to NFPA
 6. The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.
 7. Shaw approved type or Belden equivalent.
- B. Where multi conductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame retardant PVC jacket.

2.2 RTD AND MULTI-CONDUCTOR SHIELDED CABLE

- A. RTD cables shall be UL approved and shall be constructed as follows:

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1. Three (3) or more copper conductors, stranded, minimum #18 AWG.
2. PVC insulated for 600V.
3. One hundred (100%) percent coverage aluminum foil or tape shield.
4. Separate bare stranded copper drain wire.
5. Overall flame retardant PVC jacket to meet latest UL standards

2.3 CABLES

- A. As per Section 16140.
- B. Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type TWH polyethylene insulation with shielding of tape coated with paramagnetic material tape coated with diamagnetic material, wire braid metalized tapes over each conductor pair and overall covering of polyethylene jackets interlocked armour of aluminum strip.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONTROL CABLES

- A. Install control wiring as follows:
 1. In conduit systems in accordance with Section 16111.
 2. In underground ducts in accordance with Section 16112
 3. In wireways and auxiliary gutters in accordance with Section 16121.
- B. Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 12 inches' length of liquid tight flexible conduit to connect the field sensors to the conduit. Refer to Division 16 conduit or cable tray requirements.
- C. Where armored instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.
- D. At each end of the run leave sufficient cable length for termination.
- E. Terminate armor with approved connector.
- F. Do not make splices in any of the instrumentation cable runs. Where splices are required, obtain approval from the Engineer prior to installing the cable.
- G. Where splices are necessary in instrumentation cables other than coaxial cables, perform such splices on terminal blocks in terminal boxes. Keep splices in instrumentation cable to a minimum and separated physically from power circuits. Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.
- H. Where splices are made to coaxial cables, use standard coaxial cable connectors.

- I. Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling / local control panels.
- J. Protect all conductors against moisture during and after installation.

3.2 ANALOG SIGNALS

- A. Use TPSH cable for all low level analog signals such as 4-20 mA, 1-5 VDC, 0-10 VDC, pulse type circuits 24 VDC and under, and other signals of a similar nature.
- B. Use RTD cable for connections between RTDs and transmitters. Install control cables in conduit were indicated.

3.3 DIGITAL SIGNALS

- A. Use TPSH cable for all low level input (24V and below) and output signals to the plant control system.
- B. Use specified cable or wire and conduit for power to instruments, for 120V signals other than those mentioned above and as otherwise indicated on the drawings. Use stranded wire and cable to supply power to instruments.
- C. For discrete wiring use #14AWG THWN. Color code shall be:
 - 1. White 120VAC neutral
 - 2. Black 120VAC hot – power circuit
 - 3. Red AC Control circuits
 - 4. Blue DC Control Circuits - +24VDC
 - 5. Brown DC Control Circuits - 0V
 - 6. Red 120 VAC Discrete Inputs
 - 7. Yellow 120 VAC Discrete Outputs
 - 8. Black/White Analog Inputs & Outputs
 - 9. Orange UPS Line & Load
 - 10. Gray UPS Neutral
 - 11. Green Ground

3.4 INSTRUMENT POWER SUPPLY– 120VAC

- A. Use 2C + GND #12AWG cable unless otherwise noted.

3.5 CONDUCTOR TERMINATIONS

- A. All equipment supplied shall be equipped with terminal blocks to accept conductor connections.
- B. Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with Burndy-YAE-2 or STA-KON, self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.
- C. Use heat shrink printable labels to identify individual terminated wires in a control cable.

3.6 TESTING

- A. Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable manufacturer.

3.7 IDENTIFICATION

- A. Identify all instrumentation cables.
 - 1. Identify each conductor with wire numbers using a machine printed heat shrink wire marker.

END OF SECTION

SECTION 17120

ENCLOSURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment, products and execution must meet all requirements as detailed in Section 17010. This section covers the requirements of Instrumentation and Control Panel enclosures.
- B. The I/O and wiring marshalling panels are defined as the panels located in the station to arrange and group field wiring in proper order and allow for easier installation and troubleshooting.
- C. The local control panels are defined as the panels located in the station and where the control processors and/or associated I/O modules, and various communication modules and equipment are installed and all field wiring from the associated instruments is terminated. These panels will be connected to, but installed remotely from, the marshalling panels in a location of easy and unrestricted access for the plant operators.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 16010 Electrical General Provisions

1.3 GENERAL REQUIREMENTS

- A. The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any distortion or warping.
- B. The enclosures shall be sized to accommodate the proper layout and mounting of equipment devices as per the drawings and specifications.
- C. The contractor shall supply all instruments and components mounted on or within panels unless otherwise noted.
- D. All free-standing enclosures must be installed on 4 inches concrete house-keeping pads.

1.4 DOCUMENTATION

- A. Refer to Section 01330, Submittal Procedures for Submittal requirements.

PART 2 - PRODUCTS

2.1 PANEL ENCLOSURES

- A. Provide NEMA Type 1/12 gasketed enclosures in electrical rooms and control rooms.
- B. All enclosures for mounting outside of electrical rooms and control/server rooms to be NEMA Type 1/12 as a minimum unless otherwise specified or required to meet the electrical area classification.

- C. All local control panels with NEMA 1/12 rating must have ventilation louvers, an exhaust fan and thermostat. All local control panels installed outside or non air-conditioned environments shall have an integral heater complete with thermostat.
- D. All local control panels with 1/12 rating must have positive air pressurization.
- E. All enclosures to have a corrosion inhibitor:
 - 1. Daubrite 5 Disk VCI Emitter for enclosures < 5cu ft.
 - 2. Daubrite 10 Disk VCI Emitter for enclosures > 5 cu. ft.
- F. Unless otherwise specified, provide outside finishes on all enclosures in ANSI 61 Grey.
- G. Each enclosure must be supplied with a data pocket for storing wiring diagrams, operation manuals and other documentation inside the enclosure.
- H. Enclosures for mounting field control indicator lamps and switches in unclassified areas to be approved model die cast enclosures. Allen-Bradley model 800H-xHHX7, or equal from Telemecanique or ABB modular series.
- I. Supply, fabricate, checkout, layout, document and deliver to site fully equipped and functional panels.
- J. Fabricate panels/enclosures from 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing line-up. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.
- K. Provide panels with front access only. Doors shall be key lockable and fitted with 3-point heavy duty latching assemblies. Provide a continuous piano hinge and a pneumatic hold open device on each door.
- L. Finish the interior of the enclosure with white paint. Provide a switched fluorescent light fixture and 120VAC duplex convenience receptacle inside the enclosure.
- M. Supply all components contained on or within the panels fully wired under this section of the specification.
- N. For necessary information regarding the engineering and manufacturing of the Local Control Panels, refer to Local Control Panel drawings, the applicable Instrumentation Standard Details in Section 17440, Instrument loop Diagrams in Section 17700, all applicable drawings and specifications and installation and user manuals for the selected equipment.
- O. Panel enclosures supplied as I&C local control panels and housing PLC's, Remote I/O modules HMI modules and other control equipment shall be supplied with devices to protect the equipment from damage due to supplied power failure, spikes and drops, noise/harmonics and temporary power failure. Power for all instruments shall be from the UPS system.
- P. The Local Control Panel drawings represent suggested control panel layout. It is the contractor's responsibility to build the Local Control Panels based on actual physical dimensions of the supplied equipment and panel components. Final layout and panel size will be determined at the shop drawing approval stage. Fuses required shall be determined based on actual instrumentation provided.

2.2 WIRING AND ACCESSORIES

- A. Provide wiring inside the panels according to the following specifications:
1. Control wiring to be a minimum of #16 AWG tinned or crimped ferrule stranded copper; insulation rated at 600 V.
 2. Wiring for power distribution shall be a minimum of #14 AWG tinned or crimped ferrule stranded copper; insulation rated at 600 V.
 3. Analog wiring to be a minimum of #18 AWG single pair copper 300V CIC white/black cable with overall foil shield and drain wire. The black wire shall be positive and white wire shall be negative. Drain wires shall be clipped in the field and terminated on individual terminal blocks in the control panel. The shield shall be grounded at only one end in the control panel grounding terminals, and cut back and insulated at the instrument end.
 4. Refer to Division 16 for cable routing requirements.
- B. Tag each wire at both ends with a heat shrink sleeve that is machine printed.
- C. Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to relevant electrical codes. As a minimum separate control wiring from analog signal and communications wiring.
- D. Run all wiring in enclosed plastic wireways such as Panduit. Size all wireways so that the total cross sectional area of the insulated wire and cable does not exceed forty (40%) percent of the cross sectional area of the wireway.
- E. Provide a minimum clearance of 2 inches between wireways and any point of wire termination.
- F. Terminate all wiring, incoming and outgoing, at terminal strips mounted inside the panels. Identify each terminal strip with a terminal strip number, defined as follows:
1. Wire identification to use the connected field device tag name with the wire's corresponding terminal number appended to it.
 2. Identify every joint and/or terminal of the above wire run with the same identifier until the wire meets another tagged device, at which point the wire identifier will change to use the new device name and terminal number.
 3. Identify spare wires by using the destination identifier, i.e., the location and terminal identifier of the opposite end of the wire are combined to form the wire tag. All spare wires must be terminated in the dedicated terminals at both ends.
 4. Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal block and all external wire connections are made on the outboard side.
- G. Provide a 120 VAC panel power distribution system and a 24VDC power distribution system in each panel. Provide a thermal magnetic circuit breaker on each main power circuit and a fused terminal block with blown fuse indicator for each branched circuit off the main.
- H. Provide disconnect type fused terminal blocks Phoenix Contact, Weidmuller or Wago to isolate field wiring that is powered or sourced from the panel.

- I. Provide sufficient terminals so that not more than two (2) wires are connected to the same terminal. Provide twenty (20%) percent spare terminal capacity at each terminal block assembly.
- J. Wire terminals shall be Allen-Bradley interface modules, Phoenix Contact, Weidmuller or Wago of type color coded as follows (except for interface modules):
 - Red = positive 24Vdc
 - Black = 0Vdc common and analog signal plus
 - White = analog signal common and VAC neutral
 - Grey = 120 VAC
 - Green = Ground
 - Yellow = Shield
- K. Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be black lamicoid with white lettering, a minimum of 1 inch x 3 inches in size with up to three lines of ½ inch lettering. Securely fasten nameplates in and situate them in a visible location.
- L. Every cable entering or leaving the enclosure shall be labelled with permanent marking identification subject to the review by the Engineer.

2.3 PANEL GROUNDING

- A. Provide noise free low resistance grounding connection using stranded ground wire to all equipment installed in the panel according to manufacturer's recommendations and all applicable standards and codes.
- B. Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshaling panel.
- C. Provide 1 x 8 inch copper grounding bus mounted in each local control panel c/w grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor. The grounded bus shall be bonded to the ground.
- D. Provide in each marshaling panel an isolated grounding buss bar 1/4 x 1 x 16 inches, equipped with necessary lugs for accepting two #2 AWG grounding conductors. The grounded bus shall be bonded to the ground.
- E. Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for back panels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.
- F. Bond each enclosure door to the grounding lug.

2.4 LOCAL CONTROL AND PLC PANEL EQUIPMENT AND INSTRUMENTS

- A. Provide panel equipment and instruments, as applicable, unless otherwise indicated:
 - 1. Power Supply 24VDC, 10A
 - a. Input: 120VAC
 - b. Output: 24VDC, 10A

- c. Din Rail Mounted
- d. Temperature Rating: +10°F to +120°F (without de-rating)
- e. Efficiency: $\geq 87\%$
- f. Mount in control panels as per drawings, specifications and manufacturer's recommendations.
- g. Relay Output: 120VAC, 2A to indicate Power OK status.
- h. Approved Manufacturers: Siemens SITOP, Allen Bradley 1606-XL series, Phoenix Contact Quint power series, Sola Heavy-Duty SDN series or Weidmuller.

2. Power Supply 24VDC, 4A

- a. Input: 120VAC
- b. Output: 24VDC, 4A
- c. Din Rail Mounted
- d. Temperature Rating: +10°F to +120°F (without de-rating)
- e. Efficiency: $\geq 85\%$
- f. Mount in control panels as per drawings, specifications and manufacturer's recommendations.
- g. Relay Output: 120VAC, 2A to indicated Power OK status.
- h. Approved Manufacturers: Siemens SITOP, Allen Bradley 1606-XL series, Phoenix Contact Quint or Mini power series, Sola Heavy-Duty SDN series or Weidmuller.

B. Surge Suppressor

- 1. Input: 120VAC
- 2. Output: 120VAC, pure sine wave
- 3. Din Rail Mounted
- 4. Current: min 10A
- 5. Temperature Rating: +10°F to +100°F (without de-rating)
- 6. Dry 120VAC rated contacts to indicate device failure
- 7. Warranty: 10 years
- 8. Mount in control panels as per drawings, specifications and manufacturer's recommendations.

9. Approved Manufacturers: Liebert Isatrol Elite and Sola Heavy-Duty STV25K series or Phoenix Contact, Weidmuller or Wago series.

C. Pilot Lights

1. Provide pilot lights of LED type for extended lamp life, oil tight, push to test, complete with appropriate color lenses. Normal colors used are run=green, stop=red unless otherwise depicted elsewhere. Refer to Division 16 for additional information.

D. Terminals

1. Provide strap screw type terminal blocks rated for 600 volts.
2. Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks to be identified by the electrical ground symbol.
3. Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors equal to Panduit PAN-TERM series or T&B STA-KON series.
4. Terminals to be Phoenix Contacts, Weidmuller or Wago reference as follows;
 - a. DIN Rail NS 35/7.5 PERF 2000MM
 - b. UT 2.5 Terminal Block
 - c. UT 2.5-PE Ground Block
 - d. UTTB 2.5 Two Level Terminal Block
 - e. UT 4-HESILED 24 (5x20) Fused Terminal Block – for 24VDC rated circuits c/w all required fuses
 - f. UT-4-HESILED 250 (5x20) Fused Terminal Block – for 120VAC rated circuits c/w all required fuses
 - g. CLIPFIX 35-5 End Bracket
 - h. D-UT 2.5/10 End Cover for Terminal Block
 - i. DP-UTTB 2.5/4 End Cover for Two Level Terminal Block
 - j. FBS 2-5 Bridge
5. Provide a group of terminals for each of 120 VAC hot and neutral and 24 VDC positive and negative power. Distribution wiring to have a thermal magnetic circuit breaker upstream of all major blocks of loads, adequately sized to protect the connected load while not causing nuisance tripping. Provide nickel-plated terminals for all high capacity applications in excess of 15 A.
6. Provide Phoenix Contact disconnect type terminal blocks w/fuses for each load or loop powered from the control panels.
7. All terminals shall be identified with marker pins and/or strips.

E. Nameplates

WTP OZONE GENERATION BUILDING CHILLER REPLACEMENT

1. Refer to Section 17010 for nameplate specification.
- F. Signal Current Isolator
1. Isolator to provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits.
 2. Isolator to be housed in a NEMA 250, Type 4/7 conduit body and derive its operating power from the signal input circuit.
 3. Input and output signals to be 4-20mA DC, with an error not exceeding 0.1% of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.
 4. Isolator to be by Phoenix Contact, Weidmuller or MTL.
- G. Isolation Relay
1. Three isolated channels
 2. Rated for Class 1 Zone 0
 3. Power Supply: 120VAC
 4. Relay outputs: Three dry contacts 120VAC rated N.O.
 5. Fail-safe earth fault protection
 6. Reference Model: MTL 2213.
 7. Approved products from; Phoenix Contact, Weidmuller or Turk
- H. Consumables
1. Supply all consumables such as fuses, lamps, bulbs, etc., until and during start-up and commissioning. At completion of commissioning, provide 10% spare inventory of each type of consumables.
 2. Provide a tabulated list of all consumables utilized, indicating where used, type, rating, and reorder details. Include the list with the operation and maintenance manual information.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate as indicate on the drawings
- B. Connect instrumentation, power, control, communication cables and field wiring,
- C. Conduit and cable entrance shall be from bottom only, unless otherwise specified.
- D. All spare I/Os on the PLC shall be wired to a terminal strip and clearly marked.

3.2 MOUNTING HEIGHT

- A. Unless otherwise specified or a conflict exists, mount all panels, starters and disconnects 8 inches to top of cover.

3.3 IDENTIFICATION

- A. Each enclosure shall be clearly identified with a 1/8 inch thick, white lettering with blue black round nameplate mechanically attached with self tapping screws to the panel door. The nameplate to indicate panel name as indicated on drawings.
- B. If more than one power source is present in a panel, a separate warning nameplate with red face and white core, mechanically attached with self tapping screws to the panel door shall be provided. The nameplate to indicate the number of power sources and their origin.
- C. All instruments within the panel shall be identified as per 2.5.A.
- D. Provide a list of all circuit breakers and fuses laminated in plastic. The list shall be located in each associated enclosure.
- E. All wires shall be identified.
- F. Size and wording on nameplates to be submitted for approval.

3.4 REFERENCES

- A. Refer to Section 17010.

3.5 RELATED WORK

- A. Interconnection to the associated panels terminal strips, communication and field devices.
- B. Installation of interconnecting cables to field devices, instruments and Communication devices.

END OF SECTION

SECTION 17126

INDUSTRIAL CONTROL NETWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of all Industrial Ethernet Equipment.
- B. Refer to Section 17010 for general instrumentation and control requirements related to communication requirements.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17720 Computerized SCADA System
- D. 17800 Testing and Calibration for Instrumentation
- E. 17810 Commissioning and Start-Up

1.3 REFERENCES

- A. Refer to Section 17010.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All provided equipment and material to be rated for industrial use.
- B. Provide shop drawings and product data in accordance with Division 1 and Section 17010.

2.2 CABLES

- A. Provide industrial Ethernet Cat 6 24 AWG Bonded-Pair cables Al interlocked armour PVC outer jacket cable.
- B. Maximal distance 100m
- C. Color code: Orange or Blue
- D. Unarmored cable shall be installed in a dedicated conduit and armored cable shall be installed in Division 17 instrumentation cable trays.
- E. No splices are allowed.

SECTION 17130

INSTRUMENTATION PANEL COMPONENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of miscellaneous instrumentation and control components.
- B. Refer to Section 16010 and 17010 for general electrical, instrumentation and control requirements

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17720 Computerized SCADA System
- D. 17800 Testing and Calibration for Instrumentation
- E. 17810 Commissioning and Start-up

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 GENERAL

- A. Use normally open contacts for alarm actuation which close to initiate the alarm.
- B. Use normally open contact outputs to control equipment. The contacts close to start the equipment.
- C. For contacts monitored by solid state equipment, such as programmable controllers or annunciators, hermetically seal and design for switching currents from 20 to 100 mA at 24 volts DC.
- D. For contacts monitored by electromagnetic devices, such as mechanical relays, rate NEMA ICS 2, designation B300.
- E. Provide double barriers between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
- F. Use switch electrical enclosures that are rated NEMA 4X as a minimum.
- G. Where required, use 120 VAC switches that have a 4A rating.

PART 2 - PRODUCTS

2.1 SELECTOR SWITCH

- A. 2 or 3 position maintained, unless indicated spring return, as per Drawings and Specifications
- B. Mounting hole size 30.5 mm with standard knob, front enclosure NEMA 4 with front panel mounting ring mounting method.
- C. One million mechanical cycles.
- D. Legend with legend as indicated on drawings and specifications.
- E. Each position to have minimum two sets of N.O. contacts rated at 10A at 120VAC.
- F. Approvals: UL
- G. Approved manufacturer Allen Bradley Bulletin 800T equal from Cutler-Hammer, Telemecanique or ABB modular series.

2.2 PILOT LIGHTS

- A. Cap color as per drawings and specifications.
- B. Mounting hole size 30.5mm with standard knob, front enclosure NEMA 4 with front panel mounting ring mounting method.
- C. LED type, voltage rating as per drawings and specifications.
- D. Legend plate with legend as indicated on drawings and specifications.
- E. Push to test type.
- F. Approval: UL
- G. Approved manufacturer Allen Bradley Bulletin 800T or equal from Telemecanique or ABB modular series.

2.3 PUSH BUTTONS

- A. Flush head unit.
- B. Mounting hole size 30.5mm with standard knob, front enclosure NEMA 4 with front panel mounting ring mounting method.
- C. 250,000 mechanical cycles.
- D. Legend plate with legend as indicated on drawings and specifications.
- E. Each position to have minimum of three sets of N.O. contacts rated at 120VAC.
- F. Approval: UL

- G. Approved manufacturer Allen Bradley Bulletin 800T or equal from Telemecanique or ABB modular series.

2.4 CIRCUIT BREAKERS IN CONTROL PANEL

- A. Finger safe design.
- B. A positively trip-free mechanism (breaker cannot be defeated by holding the handle in ON position).
- C. Mounts on DIN rail.
- D. Tripping Characteristics: Type C.
- E. Maximum voltage: 240VAC.
- F. Electromechanical life: 6000 operations (1 operation = 2 switching events ON/OFF).
- G. Interrupt Rating: 1 pole 10kA @240VAC
- H. Approval: UL
- I. Approved manufacture: Allen Bradley Bulletin 1492-SPU or equal from Weidmuller or Telemecanique.

2.5 GENERAL PURPOSE RELAYS

- A. 4DPDT AgCdO contacts, rated 10A @ 120VAC
- B. Coil Voltage as required (24VDC, 24VAC, 120VAC)
- C. Plug-in Quick Connect Solder Terminals
- D. DIN Rail mounted bas with screw terminals.
- E. LED or mechanical relay status indication.
- F. Life expectancy: 250,000 cycles
- G. Approved product; Omron LY4N, Omron MY4N or equal from Allen-Bradley, Telemecanique or Idec.

2.6 MAG FLOWMETER INTERPOSING RELAYS

- A. Solid State Relay
- B. Load Voltage: 120VAC
- C. Control (Input) Voltage: 24VDC
- D. DIN Rail mounted bas with screw terminals.
- E. LED relay status indication.
- F. Life expectancy: 200,000 energized hours.

- G. Approvals: UL
- H. Approved product; Allen Bradley Bulletin 700-SK, Omron, Telemecanique or ABB.

2.7 PLC DIGITAL OUTPUT INTERPOSING RELAY

- A. 1SPDT contact
- B. Contact Voltage: 24VDC, 120VAC
- C. Control (Input) Voltage: 24VDC
- D. DIN Rail mounted.
- E. LED or mechanical relay status indication.
- F. Approvals: UL
- G. Approved product; Phoenix Contact – type ART-NR.2961105, Allen Bradley or Weidmuller.

2.8 E-STOP SWITCH

- A. Push – Pull and Twist to release.
- B. Two positions
- C. Non illuminated.
- D. Additional contacts: 3 N.O. and 3 N.C. (3 x Allen Bradley 800T-XA)
- E. Built-in contacts: 1 N.O. and 1 N.C.
- F. UL Approved
- G. Reference Product: Allen Bradley 800T-FXT6A1 or equal from Telemecanique or ABB

2.9 POSITION SWITCH – DOOR CONTRACT

- A. Mechanical Protection: IP67.
- B. Accessories: Lever arm or as required by the application.
- C. Built-in contacts: 1 N.O. and 1 N.C.
- D. UL Approved
- E. Model: Siemens 3SE2, Schneider 9007C or equal from Allen-Bradley.

2.10 KEY SWITCH

- A. Two position – maintained
- B. 2.5 mm two positions
- C. Contacts: 3 N.O.

D. UL Approved

E. Model: Allen Bradley 800FM or equal from Telemecanique or ABB

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and wire as indicated on the drawings.

END OF SECTION

SECTION 17210

PRIMARY ELEMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Process taps and primary elements as detailed in Division 11.
- B. Equipment, Products and Execution must meet all requirements detailed in Section 17010.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17800 Testing and Calibration for Instrumentation
- C. 17810 Commissioning and Start-up

PART 2 - PRODUCTS

2.1 PROCESS TAPS

- A. Provide pressure gauge & sensor and thermowell taps. Coordinate requirements with Division 11. Refer to P&ID drawings and Division 17 installation details.

2.2 PRIMARY ELEMENTS

- A. Provide primary elements and transmitters as specified on the Instrumentation Specification Sheets (ISS) of Section 17700.
- B. Provide written assurance that the instrument manufacturer approves the selection of materials of primary elements, which are in contact with the specified process fluid and inert to the effects of the process fluid.
- C. Provide drip pots installed below sensing elements measuring gas. Provide seamless, stainless steel drip pots consisting of a 2 inch by 1 foot pipe with an isolating valve and a drain valve. Provide a separate drip pot for each sensing line. Locate the drain valve within 1 ½ feet of the floor.
- D. Each pressure gauge & sensor and pressure switch shall be isolated from the process liquid by a diaphragm seal as shown on the drawings. Provide diaphragm seals as shown on the drawings and ISS. Refer to P&ID drawings and Division 15 installation details:
- E. There are two types of diaphragm seal isolators:
 - 1. The isolator shall consist of a 316-stainless steel housing, and a Buna-N flexible liner. The diaphragm seal shall have the capability of being isolated so that in the event of plugging, the elastomer slurry ring area, which isolates the instrument, can be flushed. The diaphragm seal shall be tapped for a 1/2 inch NPT gauge connection. Diaphragms shall be "Red Valve Series 42 Diaphragm Seals" with isolation valves for flushing.

2. The isolator shall consist of a carbon steel housing, carbon steel assembly flanges, and a Buna-N flexible liner. The isolator shall be suitable for installation between two flat-faced, ANSI/ASME B16.1, Class 125 cast iron pipe flanges and shall be tapped for a 1/2 inch NPT gauge connection. Isolators shall be Ashcroft series, Robbins & Myers "RKL Series W Pressure Sensor/Isolator", or Red Valve "Series 40 Flanged Sensor".
- F. Provide ethylene glycol factory filled assembly calibrated by the manufacturer when in-line pressure sensors are specified with a pressure gauge and/or a pressure switch and/or pressure sensor. All necessary fittings to be provided by the contractor.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 17300

INSTRUMENT DEVICE REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General instrumentation requirements.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17800 Testing and Calibration for Instrumentation
- C. 17810 Commissioning and Start-Up

1.3 GENERAL INSTRUMENTATION REQUIREMENTS

- A. Provide instruments with conformably coated printed circuit boards if available from the listed manufacturers in order to prevent damage by dust, moisture, fungus and airborne contaminants.
- B. Provide instruments complete with mounting hardware, floor stands, sunshades, wall brackets or instrument racks as required by the manufacturer.
- C. Provide instrument enclosures NEMA rated for the environment. In areas subject to flooding, provide submergence rated enclosures. Enclosures in process areas a minimum of NEMA 1/12 .

1.4 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. In addition to the requirements of Section 01330, provide the following for each model instrument provided:
 - 1. Manufacturer's design and performance specification data and descriptive literature.
 - 2. Equipment dimensioning and installation requirements and recommendations.
 - 3. Required and optional accessories lists.
 - 4. Electrical/pneumatic signal and power connection diagrams.
 - 5. Calibration certifications from the manufacturer for each calibrated instrument.
 - 6. List of recommended spare parts and spare parts to be provided.
 - 7. Tag number and description.
 - 8. Instrument Data Sheets (ISA Standard -S20) with all fields completed.

9. Catalog literature edited to indicate specific items provided.
10. Mounting details for all typical installation requirements and special details for non-typical applications.
11. Methods and materials required for installation. Include power and signal connection details.
12. Other relevant submittal information as required in the particular instrument specification.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Provide instrumentation as required and specified to provide fully functioning Instrumentation and Control system.
- B. In general, alarm contacts close to alarm. Normally closed contacts that open on detection of the alarm condition or loss of power are only required for high priority critical or safety shutdown/interlock alarms.
- C. Provide all additional data communication hardware and software required to configure, test and commission all Profibus and Modbus devices between field devices and panel devices.
- D. Unless specifically noted otherwise, all Magnetic Flow meters, Pressure and Temperature Transmitters, Level Transmitters, shall have an integral HART protocol communications options.
- E. Flow, Temperature and Pressure Transmitters shall have 4-20mA output.

2.2 INSTRUMENT MANUFACTURER

- A. Provide instruments from the manufacturers listed in Instrument Specification Sheets (ISSs) in Section 17701.

2.3 SETUP, STARTUP AND COMMISSIONING

- A. Refer to Section 17800, Acceptance Testing and Calibration and Section 17810, Commissioning and Startup.
- B. Setup, test, startup and commission all instruments.
- C. The contractor shall allow for services of a qualified equipment representative to carry out setup and testing of all instruments.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All transmitters installed outside shall have sun-shade protection.
- B. 120VAC power for instruments shall be provided by Division 16.

END OF SECTION

SECTION 17320

INSTRUMENTATION ANALYTICAL ELEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section specifies the supply and installation of various analytical instrumentation.
- B. Responsibility shall include supply and installation of all component and Vendor subsystems as to provide a fully functioning system, including supervision, calibration, checkout, start-up operating adjustment and documentation, tagging and compliance with data sheets.

1.2 RELATED SECTIONS

- A. Section 17010 – Instrumentation for Process Control General Provisions
- B. Section 17114 – Instrumentation Cables
- C. Section 17705 – Process Control System, Instrument Installation Details
- D. Section 17800 – Acceptance Testing and Calibration for Instrumentation

1.3 REFERENCES

- A. Refer to Specification Section 17010.

1.4 PRODUCT DATA

- A. Submit product data in accordance with Section 01330 Submittal Procedures.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All instrumentation, control, and electrical devices provided under this Section shall be UL approved and shall bear the UL approval seal.
- B. Provide each instrument with mechanisms that are corrosion resistant.
- C. Provide each instrument with mechanisms enclosed in a dust-proof and a moisture-proof case.
- D. Provide all indicator and gauge dials finished in permanent white with black graduations and figures.
- E. Each component shall be carefully selected and designed for a long lifetime with ample margin to withstand transient and other surge voltages which may occur in the circuits from any source in the power supply.
- F. Each component and composite instrument shall be suitable for the location and installation position at the attitude designated on the drawings, eg. horizontal, vertical or sloped position.

1. If sensing systems utilize probes then the probes shall be braced to the structure with a minimum of two 316 SS clamps to prevent sensor movement for any reason.
 2. Where probes are suspended into vessels or chambers, stilling tubes shall be used to prevent excessive movement.
 3. Sensing units shall be mounted so that interference to the sensing function is not caused by surrounding structures. The sensor shall preferably be mounted on its own support, purpose built to manufactures recommendations, to facilitate maintenance and/or adjustment.
- G. Provide each instrument powered with 120 VAC with a circuit protector fuse / breaker.
- H. All control panel mounted instruments shall be suitable for flush mounting and shall be furnished with bezel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all instruments in strict accordance with the recommendation of the manufacturer.
- B. Carry out installation, calibration and adjustment in accordance with manufacturer's installations instructions, recommended practices and as indicated on drawings and elsewhere in these specifications.

3.2 EQUIPMENT MOUNTING

- A. All mounting plates, pedestals, bolts, shims, angle iron and other miscellaneous steel or hardware items required for the securing of equipment shall be supplied unless specifically noted otherwise.
- B. All instruments to be installed in accordance with the Manufacturer's installation instructions.
- C. Instruments or raceway will be installed so as not to obstruct access routes, equipment maintenance space or space for future equipment.
- D. Where the removal of filter cartridges and heater elements is necessary, attention will be paid to instrument locations and tubing runs.
- E. Instrument supports shall be located and installed to provide a fully supported, secure system with minimum vibration.

3.3 WIRE AND CABLE

- A. Instrumentation cables shall be as described in Section 17114 of this specification. Single pair twisted shielded cable to be run in conduit.
- B. Control wiring shall be either multi-conductor Belden run in cable tray or single conductor wire run in conduit.

3.4 GAUGES AND INDICATORS

- A. Select instruments so that normal operating point is just above midpoint of instrument range. (60 – 70%)

- B. All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in engineering units.

3.5 TESTING

- A. Refer to Section 17800, Acceptance Testing and Calibration for requirements.
- B. Upon completion of testing of each device, affix a tag to the instrument certifying that calibration and testing have been completed and specifying the calibration points.

3.6 COMMISSIONING

- A. Refer to Section 17810, Commissioning and Startup.

END OF SECTION

SECTION 17330

SPARE PARTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of spare parts for Instrumentation and Controls equipment.
- B. Refer to Section 17010 for general instrumentation and control requirements.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17810 Commissioning and Start-Up

1.3 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All provided equipment and material to be rated for industrial use.

2.2 EQUIPMENT

- A. Provide spare parts per the manufacturers' recommendations for the various components. The list of recommended spare parts shall be submitted for the OWNER and ENGINEER review and approval.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide spare parts as indicated above.

END OF SECTION

SECTION 17700

INSTRUMENT LOOP DIAGRAMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Refer to Section 17010.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17701 Instrumentation Specification Sheets

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

1.5 INSTRUMENT LOOP DIAGRAMS

- A. The loop wiring diagrams will be based on the chiller manufacturer shop drawings.
- B. The diagrams are based on typical products used as the basis of design. Contractor will add information to the drawings as it is available and this information will be submitted at project completion as "As-built" record information.
- C. It is the responsibility of the integration contractor to develop and produce on 11x17 sheets individual loop drawings for all the instrument and control functions that are controlled by the waste water treatment plant PLC.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 17701

INSTRUMENT SPEC SHEETS

PART 1 - GENERAL

1.1 REFERENCES

- A. Refer to Section 17010.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17800 Testing and Calibration for Instrumentation
- C. 17810 Commissioning and Start-Up

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

1.5 INSTRUMENT SPECIFICATION SHEETS

- A. The Contractor shall develop specification sheet information for all instruments shown on the Process and Instrumentation Diagrams (P & IDs) as provided by the chiller manufacturer.
- B. The Contractor shall develop specific sheet information for all existing instruments shown on the Process and Instrumentation Diagram (P & IDs) as provided by the chiller manufacturer.
- C. Where a list of devices is not shown, the instrument specification sheet is considered generic for all instruments of that type.
- D. All instruments of the same type described in the instrument specification sheets are to be from a single source for new equipment. Design has been based on the first named supplier.
- E. Solenoid valves supplied with pneumatically actuated valves: It is the intention of the specifications that where a solenoid valve is required for the operation of a pneumatically actuated valve then this solenoid should be supplied by the valve/actuator vendor as a complete package of actuator, airset, and solenoid and required piping. Same rule applies to pneumatically operated pumps.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 17800

ACCEPTANCE TESTING AND CALIBRATION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of all necessary testing, instrument calibration, and installation verification, for each system and piece of equipment complete with written reports prior to system completion. After system completion (or part thereof), the Contractor shall commence commissioning and start-up activities as specified in this section.
- B. Conform to the general requirements of Division 1 regarding testing of the instrumentation and control equipment and coordinate instrumentation and control work to facilitate testing of other equipment.
- C. Refer to Section 17010 for general instrumentation and control requirements related to testing, calibration, and installation verification.
- D. Refer to Section 17810, Commissioning and Startup for additional information and requirements.

1.2 RELATED SECTIONS

- A. 01781, Operations and Maintenance Data
- B. 01810, Commissioning
- C. 17010, Instrumentation for Process Control General Provisions
- D. 17810, Commissioning and Start-Up

PART 2 – PRODUCTS

Not Applicable

PART 3 – EXECUTION

1.3 INSTALLATION TESTING

- A. Prior to the completion of the Work, perform comprehensive testing of the installation. Include the following activities:
 - 1. Wire insulation tests.
 - 2. Wire continuity tests including associated terminations.
 - 3. Grounding system continuity and isolation tests.
 - 4. Any other testing necessary to verify the operation of equipment and installation work.

- B. Provide the services of a manufacturer's representative for equipment to assist with any of the equipment tests to be performed. Any components, incorrect wiring, or systems found to be defective or deficient during the tests shall be repaired or replaced.
- C. Coordinate test schedules with the Engineer.
- D. The participation in testing activities and use of the equipment during testing periods by the Owner is to be allowed provided it does not adversely affect specified testing requirements. Such participation shall not relieve the Contractor of any of the obligations stipulated herein.
- E. Prior to the commencement of any testing, the Contractor shall ensure that all spare parts, expendables, and test equipment pertinent to the system being tested are on site. Test equipment shall include all necessary multi-meters, process instrument calibrators for 4-20 mA, 24 VDC devices and signal generators or simulators. Test equipment shall be provided by the Contractor and shall remain the property of the Contractor at the end of all testing.

1.4 VERIFICATION CHECKS

- A. When the system installation has been completed (or part thereof), perform detailed verification checks for all systems supplied and installed as part of the Work. In the checks and reviews, include the following:
 1. Certify that the equipment has been installed as per the Contract drawings and recommended installation procedures, reporting any discrepancies to the Engineer.
 2. Certify that the equipment power and grounding requirements have been satisfied, reporting any discrepancies to the Engineer. For the grounding system, include an itemized check of each instrument circuit to verify the correct isolation of all shields and instrument grounds.
 3. Certify that all terminations to the equipment are properly installed. Report any discrepancies to the Engineer.
 4. Certify that all wiring continuity (whether new or existing) has been verified.
 5. Certify that all process taps and instrument connections have been performed according to the requirements detailed herein and shown on the drawings.
 6. Certify that the installation (or part thereof as completed) is ready for commissioning and start-up.
 7. Witnessed Functional Acceptance Test shall be done on the complete control system. During this test, the contractor has to execute component by component and loop by loop tests. The correct results have to be verified in the field, on the associated PLCs and PCS applications. The test shall be performed using approved procedures and shall be signed off upon satisfactory completion.
- B. Undertake any corrective action found to be necessary during the course of the verification checkout and review.
- C. Report any discoveries of defects or deficiencies in writing to the Engineer for any equipment supplied by the Owner.
- D. Allow for the participation of the Owner's personnel in the verification checks. Such participation shall not relieve the Contractor of any of the obligations.

- E. Prepare the various reports and certificates described herein. Forward three (3) copies of each report or certificate to the Engineer. Clearly identify any discrepancies which require action on the part of the Engineer.

1.5 CALIBRATION AND CONFIGURATION

- A. In situ, calibrate and adjust all instrumentation to verify correct operation, range adjustment, compensation, scaling, etc. Provide instrument calibration services for all individual components such as signal transmitters, analyzers, transducers, power supplies, and like equipment where appropriate.
- B. Test equipment for calibration must have been certified and valid at time of calibration.
- C. Provide certified calibration reports for each instrument. In the reports, include, but do not limit to, such information as:
 - 1. Device tag number
 - 2. Equipment description
 - 3. Service application
 - 4. Process variable measurement range
 - 5. Description of calibration equipment used
 - 6. "As found" calibration data
 - 7. "As left" calibration data
 - 8. Date, name, and signature of technician.
- D. Include calibration reports in the Operating and Maintenance manuals described in Section 01781, Operations and Maintenance Data.
- E. Where applicable, instruments shall be factory pre-calibrated and the calibration verified in-place after installation. Provide a printed record of the factory calibration parameters for "smart" devices.
- F. Prior to calibration completely program and configure all "intelligent" instruments including entries of the appropriate range and tag number e.g., HART instruments. Tags are as shown on the P&IDs. Where specific loop configurations are required a block loop schematic will be provided for input prior to commissioning. Provide a printed record of device serial numbers against their assigned tag number and record all block assignments and configurations.
- G. Verify that devices respond to the assigned address, label each device with the address and maintain a permanent record of the addressing scheme.
- H. Instrument set up and calibration is to be conducted by a qualified technician working under the approval of the instrument manufacturer and with qualifications as described in this section.
- I. Calibrate all instruments to an accuracy of 1/2 of one percent of reading, or to the manufacturer's stated accuracy for the instrument.

LOOP CHECK REPORT

- CHECKED OUT OK
- NOT APPLICABLE
- FURTHER ACTION REQUIRED

	INSTRUMENT TAG NO.									
LOOP NO. _____										
SHEET NO. _____										
P & I DWG. NO. _____										
INSTALLATION COMPLETE										
Primary Element										
Impulse Lines										
Block and Drain Valves										
Air Supply/Filter/Reg.										
Wiring										
Tracing/Insulation/Housing										
Mounting and Location										
PLC I/O & Status										
CALIBRATED										
Impulse Lines Press. Tested										
LOOP CHECKED										
Element To Receiver										
X Mtr. to Receiver										
X Mtr./Trans. to Receiver										
X Mtr./Trans. to Switches										
Switches to Annunciator										
Interlocking Circuit										
Controller to Valve										
Controller Action D or R										

REMARKS:

READY FOR START-UP

DATE: _____

Installed by: _____

Checked by: _____

INSTRUMENT TEST REPORT

SYSTEM: _____
 SERVICE: _____
 LOCATION: _____
 MAKE: _____
 SERIAL NO.: _____
 ELEMENT: _____
 DESIGN SETTING/RANGE: _____
 SIGNAL IN: _____ OUT: _____
 INSTRUMENT CONDITION: _____
 PROJECT NO.: _____

TAG NO.: _____

 MODEL: _____
 UL: _____
 RANGE: _____
 CONTACT TO: _____ ON: _____
 ASSOCIATED INSTRUMENT: _____
 CONFORM TO SPEC: _____
 DATA SHEET: _____

TEST METHOD	TEST 1				TEST 2			
	INPUT		OUTPUT		INPUT		OUTPUT	
PROCESS	INC.	DEC.	INC.	DEC.	INC.	DEC.	INC.	DEC.
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

SECTION 17810

COMMISSIONING AND STARTUP

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. In cooperation with the Engineer and Plant Control System (PCS) System Integrator shall perform extensive commissioning and start-up functions to verify the operation of all of the systems described herein as the installation is completed. Cooperation will be required to facilitate the timely performance of these activities. The Contractors System Integrator Team, under the direction of the Engineer, will coordinate and schedule all activities associated with commissioning and start-up, and the Contractor shall cooperate and arrange its schedule of the Work to facilitate the timely performance and completion of this work.
- B. Commissioning and handover of the facilities will comply with the requirements of Division 1.
- C. It is the responsibility of General Contractor and Plant Control System (PCS) System Integrator to provide a coordinated and detailed commissioning and start-up program. The overall program will be presented to the owner and Engineer for approval.

1.2 RELATED SECTIONS

- A. Section 01810, Commissioning Plan
- B. Section 17010, Instrumentation for Process Control General Provisions
- C. Section 17800, Acceptance Testing and Calibration

1.3 COMMISSIONING

- A. Refer to the requirements of Division 1 for additional commissioning requirements.
- B. Inspections:
 - 1. Provide two (2) weeks' written notice to the Engineer prior to energizing any system to allow for inspection by the Engineer.
- C. During commissioning demonstrate to the Engineer or the Engineer's representative proper calibration and correct operation of instruments and gauges.
- D. Commissioning of the instrumentation and control system to include but not be limited to the following:
 - 1. Verify instrument calibration and provide written report.
 - 2. Verify signal levels and wiring connections to Marshalling Panel(s) and Local Control Panels for all instrumentation and control equipment.
 - 3. Function check and adjust under operational conditions the instruments and control equipment.
 - 4. Coordinate instruments and control equipment supplier's service personnel as required for complete system testing.

5. The Contractor shall make provision to be available and coordinate with the Plant Control System programming team, and the commissioning team to check the sensor signals from source to destination.
6. Instruct plant personnel in correct method of operation of instruments and control equipment.
7. Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prior to commissioning and start-up activities, a series of operational tests will be performed by the Contractor, including, but not be limited to:
 1. Verification of correct transmission of signals from field instrument to the receiving device (controller I/O modules and DeviceNet communication ports).
 2. Verification of correct transmission of signals from smart overloads, variable frequency drives (VFDs), power monitor and communication gateways.
 3. On completion of installation:
 - a. Check all controlling inputs and controlled outputs for individual correctness prior to activation of any line equipment
 - b. Perform all equipment function operation and interlock checks prior to activation of any line equipment (dry run check)
 - c. Place all equipment on line and energize for an actual controlled operation cycle
 4. Complete any corrective action necessary that has been identified as part of the checkout procedure, on an ongoing basis.
- B. Control System commissioning will be considered complete when, in the opinion of the OWNERS representative, the control system hardware or designated portion has properly operated for fourteen (14) continuous days, 24 hours per day without interruption. This 14-day period is in addition to any test periods or operational demonstrations specified elsewhere. The objective will have been achieved once it has been demonstrated that all systems are operating and have complied with the specified performance requirements herein.
- C. The complete system will be "challenged tested". Multiple modes of operation will be testing including various pump combinations and operation condition. Testing will also include failure testing and recovery. If during the "challenge test" an unexpected result/problem is observed, the Contractor will be given an opportunity to correct the unexpected result/problem. If the unexpected result/problem can't be correct (Major Failure) within 24

WTP OZONE GENERATION BUILDING CHILLER REPLACEMENT

hours, the Contractor will suspend the test, fully document the issue and propose a solution. Once this solution is accepted by Owner/Engineer and implemented, the “challenge test” will start over from original stating point. “Challenge testing” will occur during 14-day commissioning period as described in specification 17810 3.01 B, any Major Failure during test will reset the 14-day test period.

- D. Complete and submit the “Loop Check Commissioning Sheet” for each device. Include all completed forms in the instruction books.

3.2 GENERAL INSTRUMENTATION CHECK LIST

- A. Instrument cables and the individual conductors are tagged and identified.
- B. Instrument cables are terminated on approved termination blocks.
- C. Conductors are terminated in an approved manner on termination blocks and at connection points on the instrument.
- D. Conductors are terminated on identified blocks.
- E. Termination boxes and junction boxes are identified and tagged.
- F. Instrument cables are supported and strapped.
- G. Instruments (flow meter, level transmitter, etc.) are tagged and identified.
- H. Instruments are bonded to ground.
- I. Instruments are adequately supported.
- J. Instruments are located free of mechanical damage.
- K. Instruments are new.
- L. Instruments are free of dents, scratches, cracks, breaks, defects and damage.
- M. Instruments are rated for the environment in which they are placed (indoor, corrosive, classified, outdoor, etc.)
- N. Flexible connections or fittings are used to connect to the instruments.
- O. Fittings for connections are water tight and secure.
- P. Instrument control wiring is separated from power wiring.
- Q. Instrument control cable is shielded, twisted or configured in an approved manner to minimize electromagnetic and electrostatic interference.

- R. Instruments are tested, calibrated and adjusted to operate within prescribed parameters.
- S. 'Loop check sheets' and 'instrument calibration sheets' have been completed for each device.
- T. All equipment will bear the UL label.
- U. Wiring at different voltage levels within the same panel or termination box are segregated by an effective barrier.
- V. A minimum clearance of 1 ½ inch is provided between the wireway and any point of wire termination.

END OF SECTION

TECHNICAL DATA

	Specified	Shop Drawing	Installed	Verified By
Supplier	_____	_____	_____	<input type="checkbox"/>
TRANSMITTER:	_____	_____	_____	<input type="checkbox"/>
Manufacturer	_____	_____	_____	<input type="checkbox"/>
Model No.	_____	_____	_____	<input type="checkbox"/>
Serial No.	_____	_____	_____	<input type="checkbox"/>
Class/Division.	_____	_____	_____	<input type="checkbox"/>
EEMAC Enclosure Rating	_____	_____	_____	<input type="checkbox"/>
Accuracy	_____	_____	_____	<input type="checkbox"/>
Ambient Temperature Limit	_____	_____	_____	<input type="checkbox"/>
Calibration	_____	_____	_____	<input type="checkbox"/>
Max. Load	_____	_____	_____	<input type="checkbox"/>
Max. Output current	_____	_____	_____	<input type="checkbox"/>
Output Signal	_____	_____	_____	<input type="checkbox"/>
Power Supply	_____	_____	_____	<input type="checkbox"/>
Measurement Range	_____	_____	_____	<input type="checkbox"/>
-Conductivity	_____	_____	_____	<input type="checkbox"/>
-Temperature	_____	_____	_____	<input type="checkbox"/>
Transmission Signal	_____	_____	_____	<input type="checkbox"/>
SENSOR:	_____	_____	_____	<input type="checkbox"/>
Model No.	_____	_____	_____	<input type="checkbox"/>
Class/Division	_____	_____	_____	<input type="checkbox"/>
Cable Length	_____	_____	_____	<input type="checkbox"/>
Measurement Range	_____	_____	_____	<input type="checkbox"/>
Process Temperature Range	_____	_____	_____	<input type="checkbox"/>
-Peak	_____	_____	_____	<input type="checkbox"/>
-PFA	_____	_____	_____	<input type="checkbox"/>
Process Connection	_____	_____	_____	<input type="checkbox"/>

STATIC CHECK

Media in Line:	_____	Water Temp. in Line	_____
Mounting Type (Panel/Wall):	_____		_____

OPERATION CHECK

Flow Rate to Analyzer:	_____	Pressure in Process Line:	_____
Number of Samples to Analyzer:	_____		_____

WARRANTY

Start:	_____		_____
Expire:	_____		_____

Signature _____ Commissioning Agent

Signature _____ Contractor