INVITATION TO BID #2020-001837

RADIATION CENTER COOLING UPGRADE

ISSUE DATE: November 26, 2019

ITB DUE DATE/TIME: December 18, 2019 at 2:00 PM Pacific Time
***OFFICE IS CLOSED DAILY FROM NOON TO 1:00 PM**

MANDATORY PRE-BID CONFERENCE: December 10, 2019 at 2:00 PM Pacific Time at the Campus Operations Administration Building located at 850 SW 35th St, Corvallis, OR 97333

QUESTION DEADLINE: December 12, 2019 at 10:00 AM Pacific Time

PROJECT NUMBER: 2160-19

CONTRACT ADMINISTRATOR:
Shoshana Shabazz, Purchasing Analyst
Construction Contract Administration
Oregon State University
644 SW 13th St.
Corvallis, OR 97333
Phone: (541) 737-0922
FAX: (541) 737-5546
Email: Construction Contracts@oregonstate.edu

AWARD DECISION APPEALS:
Hanna Emerson, Construction Contracts Manager
Construction Contract Administration
Oregon State University
644 SW 13th St.
Corvallis, OR 97333
Phone: (541) 737-7342
FAX: (541) 737-5546
Email: hanna.emerson@oregonstate.edu

It is the Bidder's responsibility to continue to monitor the OSU Business and Bid Opportunities website for Addenda. Failure to acknowledge any Addenda in the Bid Form may cause your Bid to be considered non-responsive.

OSU standards and policies govern this solicitation (Procurement Thresholds and Methods, Procurement Solicitations and Contracts) unless otherwise referenced or stated.

PROJECT MANUAL
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PROJECT MANUAL

OREGON STATE UNIVERSITY

RADIATION CENTER COOLING DESIGN

100% CONSTRUCTION DOCUMENTS

NOVEMBER 13, 2019
T049.11

PROJECT MANUAL **SWE #T049.11**

OREGON STATE UNIVERSITY
RADIATION CENTER COOLING DESIGN

NOVEMBER 13, 2019

Owner:
Oregon State University
3015 SW Western Blvd.
Corvallis, Oregon 97333
Phone: (541) 230-0804

Contact: Dave Raleigh
Construction Project Manager
David.raleigh@oregonstate.edu

Mechanical & Electrical Engineer:
Systems West Engineers, Inc.
725 A Street
Springfield, Oregon 97477
Phone: (541) 342-7210
Contact: Paul Fooks, PE
Project Manager
pfook@systemswestengineers.com

DIVISION 26 - ELECTRICAL

OREGON STATE UNIVERSITY

NOTICE OF OPPORTUNITY

ADVERTISEMENT FOR BIDS

Oregon State University ("Owner") is accepting sealed bids from Contractors for a public improvement project at Construction Contracts Administration, Oregon State University, 644 SW 13th Street, Corvallis, Oregon 97333, until 2:00 PM local time, December 18, 2019 for the Radiation Center Cooling Upgrade located on the campus of Oregon State University, Corvallis, Oregon.

A mandatory Pre-Bid Conference and examination of the site and conditions will take place on December 10, 2019 at 2:00 PM local time. Bidders shall meet with the Owner's Representatives at the Campus Operations Administration Building located at 850 SW 35th Street, Corvallis, OR 97333. Attendance will be documented through a sign-in sheet prepared by the Owner's Representative. Prime bidders who arrive more than 5 minutes after start time of the meeting (as stated in the solicitation and by the Owner's Authorized Representative's watch) or after the discussion portion of the meeting (whichever comes first) shall not be permitted to sign in and will not be permitted to submit a bid on the project.

Plans and specifications (including the bid form) for this bid are available at the following website: https://oregonstate.box.com/s/fqez0uxk73i5yozgmrl4hew28yjqui0g. Bids will be due December 18, 2019 by 2:00 PM local time (the time stamp clock located at the front desk at 644 SW 13th Street, Corvallis, OR 97333-4238 will serve as the official time clock) at: Construction Contracts Administration, Property Services Building, 644 SW 13th Street, Corvallis, OR 97333-4238. **Note: This office is closed from 12:00 p.m. to 1:00 p.m. Office is also closed entirely on Saturday and Sunday. Bids will not be accepted at the desk in the warehouse.** In accordance with OSU Policies and Standards (***Procurement Thresholds and Methods, Procurement Solicitations and Contracts)*** late bids will not be accepted.

Bids must be submitted in a SEALED ENVELOPE that clearly indicates the project name and that a bid is contained within it.

All bidders must comply with requirements of the prevailing wage law in ORS 279C.800 through ORS 279C.870. All bidders must be registered with the Construction Contractor's Board at the time of bid submission. No bid will be considered unless fully completed in the manner provided in the "Instructions to Bidders" upon the Bid Form provided. OSU encourages bids from Minority, Women, and Emerging Small Businesses.

OREGON STATE UNIVERSITY
CONSTRUCTION CONTRACTS ADMINISTRATION

DATE OF POSTING:
November 26, 2019

INSTRUCTIONS TO BIDDERS

OSU Policies and Standards (***Procurement Thresholds and Methods, Procurement Solicitations and Contracts)*** govern this OSU procurement process.

Article 1. Definitions

1.1. Capitalized words used herein but not defined shall have the meaning set forth in the OSU General Conditions and OSU Policies and Standards. The following terms used herein shall have the meaning set forth below:

"Bid Form"- refers to OSU form provided by Owner to be completed by Bidder.

"Project Manual"- The Project Manual includes, but is not necessarily limited to, the following: the Advertisement for Bids or Notice of Contracting Opportunity, these Instructions to Bidders, Supplemental Instructions to Bidders, Bid Form, Bid Bond, OSU General Conditions, Supplemental General Conditions (if any), Sample Supplement or Agreement, Performance Bond, Payment Bond, and the Plans and Specifications.

Article 2. Scope of Work

2.1 The Work contemplated in this document shall be for the Owner in connection with the Project described in the Project Manual.

Article 3. Examination of Site and Conditions

3.1 Before making a Bid, the Bidder shall examine the Work site to ascertain its physical condition. The Bidder shall be responsible for being fully informed as to the quality, quantity and sources of supply of the materials listed on the Project Manual. Failure to comply with this Section will not release Contractor from entering into the Contract nor excuse Contractor from performing the Work in strict accordance with the terms of the Contract Documents.

3.2 The Owner will not be responsible for any loss or unanticipated costs which may arise as a result of Contractor's failure to be fully informed in advance with regard to all conditions pertaining to the Work and the character of the Work required.

3.3. No statement made by any officer, agent, or employee of the Owner in relation to the physical conditions pertaining to the Work site or quality, quantity, and supply of materials will be binding on the Owner, unless included in writing in the Project Manual or an Addendum.

Article 4. Substitute Materials Approval Process

4.1 Prior to submitting a Bid including a Substitution, the Bidder must first seek approval of the Substitution from the Architect (or Engineer, as appropriate hereafter) by submitting a written request for approval at least 10 calendar days prior to the Closing Date and Time. The Bidder submitting the request shall be responsible for its timely delivery.

4.2 Substitution approval requests shall be accompanied by samples, records of performance, certified copies of tests by impartial and recognized laboratories, and such other information as the Architect may request.

4.3 Within a reasonable time after receiving such a request the Owner (or Architect if so designated) will consider whether the Substitution sought by Bidder is of equal value, utility, as the designated product in the Project Manual.

If the requested Substitution is approved an Addendum to the Project Manual shall be issued. A copy of each Addendum shall become a part of the Project Manual.

4.4 When the Architect approves a Substitution by Addendum, it is with the understanding that the Contractor guarantees the substituted article or material to be equal or better than the one specified.

Article 5. Interpretation of Project Manual

5.1 A Bidder in doubt as to the meaning of any part of the Project Manual may submit a written request for an interpretation to the Architect at any time prior to 10 calendar days prior to the Closing Date and Time.

5.2 Any interpretation of the Project Manual will be made only by a duly issued Addendum. The Owner will not be responsible for any other explanation or interpretation of the Project Manual nor for any other approval of a particular manufacturer's process or item.

5.3 To establish a basis of quality, certain processes, types of machinery and equipment or kinds of materials may be specified in the Project Manual either by description of process or by designating a manufacturer by name and referring to a brand or product designation or by specifying a kind of material. Whenever a process is designated or a manufacturer named, brand or item designation given, or whenever a process or material covered by patent is designated or described, it shall be understood that the words "or approved equal" follow such name, designation or description, whether they do so or not.

Article 6. Execution of the Bid Form

6.1 The Bid Form relates to Bids on a specific Project Manual. Only the amounts and information asked for on the Bid Form furnished by the Owner will be considered as the Bid. Each Bidder shall Bid upon the Work exactly as set forth in the Bid Form. The Bidder shall include in the Bid a sum to cover the cost of all items contemplated by the Project Manual. Bids that fail to address alternates set forth on the Bid Form may be considered non-responsive.

6.2 Each Bid Form must: 1) Be completed in accordance with these instructions; 2) Include the appropriate signatures as noted on the Bid Form; 3) Include numbers pertaining to base Bids stated both in writing and in figures; and 4) Include the Bidder's typed or clearly printed address.

6.3 When Bidding on an alternate for which there is no charge, the Bidder shall write the words "No Charge" in the space provided on the Bid Form. If one or more alternates is shown on the Bid Form, the Bidder shall indicate whether each is "add" or "deduct."

Article 7. Prohibition of Alterations to Bid

7.1 Bids which are incomplete, or contain ambiguities or conditions not provided for in the Bid Form, may be rejected.

Article 8. Submission of Bid

8.1 Each Bid shall be sealed in an envelope, properly addressed to the appropriate project representative of the Owner, showing on the outside of the envelope the name of the Bidder and the name of the project. Bids will be received at the time and place stated in the Advertisement for Bids.

Article 9. Bid Closing and Opening of Bids

9.1 All Bids must be received by the Owner before the Closing Date and Time. Any Bids received after the Closing

Date and Time will be rejected and returned to the Bidder unopened.

9.2 At the time of opening and reading of Bids, each Bid received, irrespective of any irregularities or informalities, will be publicly opened and read aloud.

Article 10. Acceptance or Rejection of Bids by Owner

10.1 Unless all Bids are rejected, the Owner will award the Contract based on the lowest responsive Bid from a responsible Bidder. If that Bidder does not execute the Contract, the Contract will be awarded to the next lowest responsible Bidder or Bidders in succession.

10.2 The procedures for Contract awards shall be in compliance with the provisions of OSU Standards adopted by the Owner.

10.3 The Owner reserves the right to reject all Bids and to waive minor informalities.

10.4 The Owner reserves the right to hold the Bid and any required Bid security, of the three lowest Bidders for a period of 30 calendar days from the time of Bid opening pending award of the Contract. Following award of the Contract, any Bid security furnished by the three lowest Bidders may be held 20 calendar days pending execution of the Contract. All other Bids will be rejected and Bid security returned.

10.5 In determining the lowest Bidder, the Owner reserves the right to take into consideration any or all authorized base Bids as well as alternates or combinations indicated in the Bid Form.

10.6 If Owner has not accepted a Bid within 30 calendar days after the opening of the Bids, each of the three lowest Bidders may withdraw the Bid submitted and request the return of any Bid security then held.

Article 11. Withdrawal of Bid

11.1 At any time prior to the Closing Date and Time a Bidder may withdraw its Bid. This will not preclude the submission of another Bid by such Bidder prior to the Closing Date and Time.

11.2 After the Closing Date and Time, no Bidder will be permitted to withdraw its Bid within the time period specified in Article 10 for award and execution, except as provided for in that Article.

Article 12. Execution of Contract, Agreement, Performance Bond and Payment Bond

12.1 The Owner will provide the successful Bidder with Contract Documents within 10 calendar days after the award of the Contract. The Bidder shall be required to execute the Contract as provided, including a Performance Bond and a Payment Bond from a surety company licensed to do surety business in the State of Oregon, within 20 calendar days after the award of the Contract. The Contract Documents shall be delivered to the Owner in the manner stated in the Notice of Award.

Article 13. Recyclable Products

13.1 Contractors must use recyclable products to the maximum extent economically feasible in the performance of the Contract.

BID FORM

ITB NUMBER & NAME: 2020-001837, Radiation Center Cooling Upgrade

BID DUE DATE AND TIME: _____
*(**fill in**)*

FROM: _____
*(**Name of Contractor**)*

TO: Oregon State University ("Owner")
Construction Contracts Administration
644 SW 13th Street
Corvallis, Oregon 97333

1. The Undersigned hereby proposes to furnish all material and labor and perform all work hereinafter indicated for the above project in strict accordance with the Contract Documents for the Base Bid as follows:

_____ Dollars ($_____)

and the Undersigned agrees to be bound by the documents either contained in or incorporated by reference in the Invitation to Bid and ADDENDA numbered ____ through____, inclusive. ***(fill in blanks)***

The Undersigned proposes to add to or deduct from the Base Bid indicated above the items of work relating to the following Alternate(s) as designated in the Specifications:

ALTERNATE 1:	Delete reactor building ASU-1 controls requirement.	(***circle one***)	ADD / DEDUCT :	$_____
ALTERNATE 2:	Delete work associated with exhaust fans EF1 thru EF-4.	(***circle one***)	ADD / DEDUCT :	$_____

2. The work shall be completed within the time stipulated and specified in Division 1, Section 01 11 00, of the Specifications.

3. The Undersigned certifies that: (1) This Bid has been arrived at independently and is being submitted without collusion with and without any agreement, understanding, or planned common course of action with any other vendor of materials, supplies, equipment or services described in the invitation to bid designed to limit independent bidding or competition; and (2) The contents of the Bid have not been communicated by the Undersigned or its employees or agents to any person not an employee or agent of the Undersigned or its surety on any Bid security furnished with the Bid and will not be communicated to such person prior to the official opening of the Bid.

4. The Undersigned agrees, if awarded a contract, to comply with the provisions of ORS 279C.800 through 279C.870 pertaining to the payment of the prevailing wages.

5. Contractor's CCB license number is _____. As a condition to submitting a Bid, Contractor must be licensed with the Oregon Construction Contractors Board in accordance with ORS 701.021 to 701.128, and disclose the license number. Failure to be licensed and disclose the number will render the Bid unresponsive and it will be rejected, unless contrary to federal law.

6. The Bidder hereby certifies that all subcontractors who perform construction work as described in ORS 701.005(5) are licensed with the Construction Contractors Board in accordance with ORS 701.021 to 701.128 at the time the Bid is submitted.

7. Contractor's Project Manager for this project is: _____,

Email: _____ Cell Phone: _____.

8. The Undersigned agrees, if awarded the Contract, to deliver to Owner, a satisfactory Performance Bond and Payment Bond, each in an amount equal to one hundred (100) percent of the Contract sum, using forms provided by the Owner. The surety requested to issue the Performance Bond and Payment Bond will be:

_____.
*(**name of surety company - not insurance agency**)*

The Undersigned hereby authorizes said surety company to disclose any information to the Owner concerning the Undersigned's ability to supply a Performance Bond and Payment Bond each in the amount of the Contract.

By signature below, Contractor agrees to be bound by this Bid.

NAME OF FIRM: _____

ADDRESS: _____

_____

FEDERAL TAX ID: _____

TELEPHONE NO: _____

SIGNATURE: _____
Authorized Signature

_____
Printed Name

******* END OF BID *******

OREGON STATE UNIVERSITY
PUBLIC IMPROVEMENT CONTRACT

This Public Improvement Contract for the **(Insert Project Name)** (the "Contract"), made by and between Oregon State University, hereinafter called OWNER, and **(Insert Contractor's Name)** hereinafter called the CONTRACTOR (collectively the "Parties"), shall become effective on **(Insert contract award date)**, or the date this Contract has been signed by all the Parties, whichever is later.

1. Contract Price, Contract Documents and Work.

The CONTRACTOR, in consideration of the sum of _____ (the "Contract Price"), to be paid to the CONTRACTOR by OWNER in the manner and at the time hereinafter provided, and subject to the terms and conditions provided for in the Instructions to Bidders and other Contract Documents (as defined in the Oregon State University General Conditions referenced within the Instructions to Bidders), all of which are incorporated herein by reference, hereby agrees to perform all Work described and reasonably inferred from the Contract Documents. The Contract Price is the amount contemplated by the Base Bid adjusted for Alternates____, as indicated in the accepted Bid.

Also, the following documents are incorporated by reference in this Contract and made a part hereof if checked for inclusion [X]:

[ ] (RESERVED)

2. Representatives.

CONTRACTOR has named **(Insert Name)** its' Authorized Representative to act on its behalf. OWNER designates, or shall designate, its Authorized Representative as indicted below (check one):

A. [ ] Unless otherwise specified in the Contract Documents, the OWNER designates **(Insert Name)** as its Authorized Representative in the administration of this Contract. The above-named individual shall be the initial point of contact for matters related to Contract performance, payment authorization, and to carry out the responsibilities of the OWNER.

B. [X] Name of OWNER'S Authorized Representative shall be submitted by OWNER in a separate writing.

3. Contract Dates.

COMMENCEMENT DATE: Within **(Insert # of Days)** days of the execution of the Contract ("Execution").

SUBSTANTIAL COMPLETION DATE: **(Insert # of Days)** from Contract Execution **(or a date certain)**.

FINAL COMPLETION DATE: **(Insert # of Days)** from Contract Execution **(or a date certain)**.

4. Integration

The Contract documents constitute the entire agreement between the parties. There are no other understandings, agreements or representations, oral or written, not specified herein regarding this Contract.

CONTRACTOR, by the signature below of its authorized representative, hereby acknowledges that it has read this Contract, understands it, and agrees to be bound by its terms and conditions.

In witness whereof, Oregon State University executes this Contract and the CONTRACTOR does execute the same as of the day and year indicated below.

CONTRACTOR DATA:
(Insert Contractor Name & Address)

CONTRACTOR NAME:

CONTRACTOR FEDERAL ID #

CONTRACTOR CCB #

[Payment information will be reported to the IRS under the name and taxpayer ID # provided above. Information must be provided prior to contract approval. Information not matching IRS records could subject Contractor to 31 percent backup withholding.]

CONTRACTOR SIGNATURE

By_____
Name/Title Date

Oregon State University

By_____

Michael J. Green Date
Vice President for Finance and Administration

OREGON STATE UNIVERSITY

PERFORMANCE BOND

Bond No._____
Solicitation _____
Project Name Advanced technology and Manufacturing Institute (ATAMI) Build Out – HP Campus B11

_____(Surety #1)	Bond Amount No. 1:	$_____
_____(Surety #2)*	Bond Amount No. 2:*	$_____
** If using multiple sureties*	Total Penal Sum of Bond:	$_____

We, _____as Principal, and the above identified Surety(ies), authorized to transact surety business in Oregon, as Surety, hereby jointly and severally bind ourselves, our respective heirs, executors, administrators, successors and assigns firmly by these presents to pay unto Oregon State University (OSU), the sum of (Total Penal Sum of Bond)

_____

(Provided, that we the Sureties bind ourselves in such sum "jointly and severally" as well as "severally" only for the purpose of allowing a joint action or actions against any or all of us, and for all other purposes each Surety binds itself, jointly and severally with the Principal, for the payment of such sum only as is set forth opposite the name of such Surety), and

WHEREAS, the Principal has entered into contract No. _____with the OSU, the plans, specifications, terms and conditions of which are contained within the Contract resulting from the above-referenced Solicitation;

WHEREAS, the terms and conditions of the Contract, together with applicable plans, standard specifications, special provisions, schedule of performance, and schedule of Contract prices, are made a part of this Performance Bond by reference, whether or not attached to the contract (all hereafter called "Contract"); and

WHEREAS, the Principal has agreed to perform the Contract in accordance with the terms, conditions, requirements, plans and specifications, and all authorized modifications of the Contract which increase the amount of the work, the amount of the Contract, or constitute an authorized extension of the time for performance, notice of any such modifications hereby being waived by the Surety:

NOW, THEREFORE, THE CONDITION OF THIS BOND IS SUCH that if the Principal herein shall (1) faithfully and truly observe and comply with the terms, conditions and provisions of the Contract, in all respects, (2) shall well and truly and fully do and perform all matters and things undertaken by Contractor to be performed under the Contract, upon the terms set forth therein, and within the time prescribed therein, or as extended as provided in the Contract, with or without notice to the Sureties, (3) shall save, defend, indemnify and hold harmless OSU and its officers, board members, employees, agents and other representatives, against any direct or indirect damages or claim of every kind and description that shall be suffered or claimed to be suffered in connection with or arising out of the performance of the Contract by

the Principal or its subcontractors, and (4) shall in all respects perform said contract according to law, then this obligation is to be void; otherwise, it shall remain in full force and effect.

Nonpayment of the bond premium will not invalidate this bond, nor shall OSU be obligated for the payment of any premiums.

This bond is given and received under authority of ORS Chapters 279C and 352, the provisions of which hereby are incorporated into this bond and made a part hereof.

IN WITNESS WHEREOF, WE HAVE CAUSED THIS INSTRUMENT TO BE EXECUTED AND SEALED BY OUR DULY AUTHORIZED LEGAL REPRESENTATIVES.

Dated this _____ day of _____, 20__.

PRINCIPAL: _____

By_____
Signature

_____
Official Capacity

Attest: _____
Corporation Secretary

SURETY: _____
[Add signatures for each surety if using multiple bonds]

BY ATTORNEY-IN-FACT:
[Power-of-Attorney must accompany each surety bond]

_____
Name

_____
Signature

_____
Address

_____
City State Zip

_____ _____
Phone Fax

OREGON STATE UNIVERSITY

PAYMENT BOND

Bond No. _____
Solicitation _____
Project Name _____

_____(Surety #1)	Bond Amount No. 1:	$ _____
_____(Surety #2)*	Bond Amount No. 2:*	$ _____
** If using multiple sureties*	Total Penal Sum of Bond:	$ _____

We, _____, as Principal, and the above identified Surety(ies), authorized to transact surety business in Oregon, as Surety, hereby jointly and severally bind ourselves, our respective heirs, executors, administrators, successors and assigns firmly by these presents to pay unto Oregon State University (OSU) the sum of (Total Penal Sum of Bond) _____ _____ (Provided, that we the Sureties bind ourselves in such sum "jointly and severally" as well as "severally" only for the purpose of allowing a joint action or actions against any or all of us, and for all other purposes each Surety binds itself, jointly and severally with the Principal, for the payment of such sum only as is set forth opposite the name of such Surety), and

WHEREAS, the Principal has entered into contract No. _____ with OSU, the plans, specifications, terms and conditions of which are contained within the Contract resulting from the above-referenced Solicitation;

WHEREAS, the terms and conditions of the contract, together with applicable plans, standard specifications, special provisions, schedule of performance, and schedule of contract prices, are made a part of this Payment Bond by reference, whether or not attached to the contract (all hereafter called "Contract"); and

WHEREAS, the Principal has agreed to perform the Contract in accordance with the terms, conditions, requirements, plans and specifications, and schedule of contract prices which are set forth in the Contract and any attachments, and all authorized modifications of the Contract which increase the amount of the work, or the cost of the Contract, or constitute authorized extensions of time for performance of the Contract, notice of any such modifications hereby being waived by the Surety:

NOW, THEREFORE, THE CONDITION OF THIS BOND IS SUCH that if the Principal shall (1) faithfully and truly observe and comply with the terms, conditions and provisions of the Contract, in all respects, (2) shall well and truly and fully do and perform all matters and things by it undertaken to be performed under said Contract and any duly authorized modifications that are made, upon the terms set forth therein, and within the time prescribed therein, or as extended therein as provided in the Contract, with or without notice to the Sureties, (3) shall save, defend, indemnify and hold harmless OSU, and its officers, board members, employees, agents and other representatives, against any claim for direct or indirect damages of every kind and description that shall be suffered or claimed to be suffered in connection with or arising out of the performance of the Contract by the Contractor or its subcontractors, (4) shall promptly pay all persons supplying labor, materials or both to the Principal or its subcontractors for prosecution of the work provided in the Contract; (5) shall promptly pay all contributions due the State Industrial Accident Fund and the State Unemployment Compensation Fund from the Principal or its

subcontractors in connection with the performance of the Contract; (6) shall pay over to the Oregon Department of Revenue all sums required to be deducted and retained from the wages of employees of the Principal and its subcontractors pursuant to ORS 316.167;(7) shall permit no lien nor claim to be filed or prosecuted against the State or OSU on account of any labor or materials furnished; and (8) shall do all things required of the Principal by the laws of this State, then this obligation shall be void; otherwise, it shall remain in full force and effect.

Nonpayment of the bond premium will not invalidate this bond, nor shall OSU be obligated for the payment of any premiums.

This bond is given and received under authority of ORS Chapters 279C and 352, the provisions of which hereby are incorporated into this bond and made a part hereof.

IN WITNESS WHEREOF, WE HAVE CAUSED THIS INSTRUMENT TO BE EXECUTED AND SEALED BY OUR DULY AUTHORIZED LEGAL REPRESENTATIVES:

Dated this _____day of _____, 20__.

PRINCIPAL: _____

By _____
Signature

_____
Official Capacity

Attest: _____
Corporation Secretary

SURETY: _____
[Add signatures for each if using multiple bonds]

BY ATTORNEY-IN-FACT:
[Power-of-Attorney must accompany each bond]

_____
Name

_____
Signature

_____
Address

_____
City State Zip

_____
Phone Fax

OREGON STATE UNIVERSITY
GENERAL CONDITIONS
FOR PUBLIC IMPROVEMENT CONTRACTS

June 30, 2017

INSTRUCTIONS: The attached **Oregon State University General Conditions for Public Improvement Contracts ("Public Improvement General Conditions")** apply to all designated Public Improvement contracts. Changes to the Public Improvement General Conditions (including any additions, deletions or substitutions) should only be made by attaching Public Improvement Supplemental General Conditions. The text of these Public Improvement General Conditions should not otherwise be altered.

TABLE OF SECTIONS

SECTION A
GENERAL PROVISIONS

A.1 DEFINITION OF TERMS

In the Contract Documents the following terms shall be as defined below:

AMENDMENT, means a writing which, when fully executed by the Parties to this Contract, constitutes a change to a Contract Document. Amendments shall be issued in accordance with the changes provisions of Section D and, if applicable, establish a Contract Price or Contract Time adjustment.

APPLICABLE LAWS, means federal, state and local laws, codes, rules, regulations and ordinances applicable to the Work and to the Contract.

ARCHITECT/ENGINEER, means the Person appointed by the Owner to make drawings and specifications and, to provide contract administration of the Work contemplated by the Contract to the extent provided herein or by supplemental instruction of Owner (under which Owner may delegate responsibilities to the Architect/Engineer), in accordance with ORS Chapter 671 (Architects) or ORS Chapter 672 (Engineers) and administrative rules adopted thereunder.

CHANGE ORDER, means a written order issued by the Owner to be later included as an Amendment. A Change Order shall not be effective until codified as an Amendment.

CLAIM, means a demand by Contractor pursuant to Section D.3 for review of the denial of Contractor's initial request for an adjustment of Contract terms, payment of money, extension of Contract Time or other relief, submitted in accordance with the requirements and within the time limits established for review of Claims in these Public Improvement General Conditions.

CONSTRUCTION CHANGE DIRECTIVE, means a written order by the Owner to the Contractor requiring a change in the Work within the general scope of the Contract Documents, issued under the changes provisions of Section D.

CONSTRUCTION SCHEDULE, means the schedule prepared by the Contractor in CPM format and approved by the Owner, and all adjustments thereto approved by the Owner, that describes sequence and timing of the Work.

CONTRACT, means the written agreement between the Owner and the Contractor comprised of the Contract Documents which describe the Work to be done and the obligations between the parties.

CONTRACT DOCUMENTS, means the Public Improvement Contract, Public Improvement General Conditions, Supplemental General Conditions if any, the accepted Offer, Plans, Specifications, Construction Change Directives, Solicitation Document and addenda thereto, Instructions to Offerors, and Supplemental Instructions to Offerors, the CM/GC's RFQ proposal, the GMP Amendment, and any other Amendment, the Construction Schedule prepared and approved in accordance with the Construction Documents, and all other required Submittals.

CONTRACT PERIOD, as set forth in the Contract Documents, means the total period of time beginning with the full execution of a Contract and, if applicable, the issuance of a Notice to Proceed and concluding upon Final Completion.

CONTRACT PRICE, means the total of the awarded Offer amount, as increased or decreased by the price of approved alternates, as indicated in the Contract Documents.

CONTRACT TIME, means any incremental period of time allowed under the Contract to complete any portion of the Work as reflected in the project schedule.

CONTRACTOR, means the Person awarded the Contract for the Work contemplated.

CPM, means a critical path method format to be used for the Construction Schedule.

DAYS, are calendar days, including weekdays, weekends and holidays, unless otherwise specified.

DIRECT COSTS, means, unless otherwise provided in the Contract Documents, the cost of materials, including sales tax, cost of delivery; cost of labor, including social security, Medicare and unemployment insurance, and fringe benefits required by agreement or custom; worker's compensation insurance; project specific insurance (including, without limitation, Builder's Risk Insurance and Builder's Risk Installation Floater); bond premiums, rental cost of equipment, and machinery required for execution of the Work; and the additional costs of field personnel directly attributable to the Work.

FINAL COMPLETION, means the final completion of all requirements under the Contract, including Contract Closeout as described in Section K but excluding Warranty Work as described
in Section I.2, and the final payment and release of all retainage, if any, released.

FINAL PAYMENT, means the last payment to the Contractor, including retainage, in connection with the Work.

FORCE MAJEURE, means an act, event or occurrence caused by f i r e , riot, war, acts of God, nature, sovereign, or public enemy, strikes, freight embargoes or any other act, event or occurrence that is beyond the control of the party to this Contract who is asserting Force Majeure.

MWESB REPORT, means an accurate report by the Contractor to the Owner identifying all Minority, Women and Emerging Small Business (MWESB) enterprises, as those terms are defined in ORS 200.005, receiving contracts throughout the course of the Work. An initial MWESB report is required (see Section E.2.9) and MWESB Reports are required annually (see Section E.2.9) and as a condition of final payment (see Section K.1). The initial report shall include the total number of contracts and subcontracts awarded to MWESB enterprises and the dollar value of their respective contracts and subcontracts. The annual reports shall include the total number of contracts and subcontracts awarded to MWESB enterprises, the dollar value of each, and the expenditure toward each contract and subcontract during the previous twelve (12) months. The final report shall include the total number of contracts and subcontracts awarded to MWESB enterprises and the dollar value of their respective contracts and subcontracts including all Contracts and Amendments incorporated during the course of the project. The reports shall only include enterprises certified with the State of Oregon as MWESB enterprises and shall include individual identification of each enterprise as a Minority business enterprise, a Women business enterprise, and/or an Emerging Small Business Enterprise, as applicable.

NOTICE TO PROCEED, means the official written notice from the Owner stating that the Contractor is to proceed with the Work defined in the Contract Documents. Notwithstanding the Notice to Proceed, Contractor shall not be authorized to proceed with the Work until all initial Contract requirements, including the Contract, performance bond and payment bond, and certificates of insurance, have been fully executed and submitted to Owner in a suitable form.

OFFER, means a bid in connection with Instructions to Bidders or a proposal in connection with a Request for Proposals.

OFFEROR, means a bidder in connection with Instructions to Bidders or a proposer in connection with a Request for Proposals.

OVERHEAD, means those items which may be included in the Contractor's markup (general and administrative expense and profit) and that shall not be charged as Direct Cost of the Work,
including without limitation such Overhead expenses as wages or salary of personnel above the level of foreman (i.e., superintendents and project managers), expenses of Contractor's offices and supplies at the job site (e.g. job trailer) and at Contractor's principal place of business and including expenses of personnel staffing the job site office and Contractor's principal place of business, and Commercial General Liability Insurance and Automobile Liability Insurance.

OWNER, means Oregon State University(OSU). Owner may elect, by written notice to Contractor, to delegate certain duties to more than one party, including without limitation, to an Architect/Engineer. However, nothing in these Public Improvement General Conditions is intended to abrogate the separate design professional responsibilities of Architects under ORS Chapter 671 or of Engineers under ORS Chapter 672.

PERSON, means a natural person or entity doing business as a sole proprietorship, a partnership, a joint venture, a corporation, a limited liability company or partnership, or any other entity possessing the legal capacity to contract.

PLANS, means the drawings which show the location, type, dimensions, and details of the Work to be done under the Contract.

PROJECT, means the development, design, construction

PUNCH LIST, means the list of Work yet to be completed or deficiencies which need to be corrected in order to achieve Final Completion of the Contract.

RECORD DOCUMENT, means the as-built Plans, Specifications, testing and inspection records, product data, samples, manufacturer and distributor/supplier warranties evidencing transfer of ownership to Owner, operational and maintenance manuals, shop drawings, Construction Change Directives, MWESB Reports, correspondence, certificate(s) of occupancy, and other documents listed in Subsection B.9.1 of these Public Improvement General Conditions, recording all Services performed.

SOLICITATION DOCUMENT, means Instructions to Bidders or Offerors or a Request for Proposal or a Request for Quotes.

SPECIFICATION, means any description of the physical or functional characteristics of the Work, or of the nature of a supply, service or construction item. Specifications may include a description of any requirement for inspecting, testing or preparing a supply, service or construction item for delivery and the quantities or qualities of materials to be furnished under the Contract. Specifications generally will state the results or products to be obtained and may, on occasion, describe the method and manner of doing the Work to be performed. Specifications may be incorporated by reference and/or may be attached to the Contract.

SUBCONTRACT, means a contract between the Contractor and a subcontractor for the performance of a portion of the Work.

SUBCONTRACTOR, means a Person having a direct contract with the Contractor, or another Subcontractor, to perform one or more items of the Work.

SUBMITTAL, means a shop drawing, product data, sample, catalog cut, or similar item for specific portions of the Work as required by the Construction Documents.

SUBSTANTIAL COMPLETION, means the date when the Owner accepts in writing the construction, alteration or repair of the improvement to real property constituting the Work or any designated portion thereof as having reached that state of completion when it may be used or occupied for its intended purpose. Substantial Completion of facilities with operating systems occurs only after thirty (30) continuous Days of successful, trouble-free operation of the operating systems as provided in Section K.3.2.

SUBSTITUTIONS, means items that in function, performance, reliability, quality, and general configuration are the same or better than the product(s) specified. Approval of any substitute item shall be solely determined by the Owner. The decision of the Owner is final.

PUBLIC IMPROVEMENT SUPPLEMENTAL GENERAL CONDITIONS, means those conditions that remove from, add to, or modify these Public Improvement General Conditions. Public Improvement Supplemental General Conditions may be included in the Solicitation Document or may be a separate attachment to the Contract.

WORK, means the furnishing of all materials, equipment, labor, transportation, services and incidentals necessary to successfully complete any individual item or the entire Contract and the carrying out of duties and obligations imposed by the Contract Documents.

A.2 SCOPE OF WORK

The Work contemplated under this Contract includes all labor, materials, transportation, equipment and services for, and incidental to, the completion of all construction work in connection with the project described in the Contract Documents. The Contractor shall perform all Work necessary so that the project can be legally occupied and fully used for the intended use as set forth in the Contract Documents. Execution of the Contract by the Contractor is an express representation (1) that the Contractor understands the intent stated herein with respect to the Preconstruction Phase Services, and (2) the Contractor's execution of an Amendment, including the GMP Amendment, shall be an express and unqualified representation that the Contractor understands the intent stated herein and therein.

A.3 INTERPRETATION OF CONTRACT DOCUMENTS

A.3.1 Unless otherwise specifically defined in the Contract

Documents, words which have well-known technical meanings or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings. Contract Documents are intended to be complementary. Whatever is called for in one, is interpreted to be called for in all. However, in the event of conflicts or discrepancies among the Contract Documents, interpretations will be based on the following descending order of precedence:

(a) Amendments and Construction Change Directives, with those of later date having precedence over those of an earlier date;

(b) The Supplemental General Conditions;

(c) Public Improvement General Conditions;

(d) The Public Improvement Contract;

(e)) Construction Change Directive;

(f) Division One (General Requirements) of the Specifications;

(g) Detailed Schedules of finishes, equipment and other items included in the Specifications;

(h) Plans and Specifications (other than Division One and the Detailed Schedules to the Specifications);

(i) Large-scale drawings on Plans;

(j) Small-scale drawings on Plans;

(k) Dimension numbers written on Plans which shall prevail and take precedence over dimensions scaled from Plans;

(l) The Solicitation Document, and any addenda thereto.

(m) The Contractor's RFQ proposal.

A.3.2 In the case of an inconsistency between Plans and Specifications or within either document not clarified by addendum, the better quality or greater quantity of Work shall be provided in accordance with the Owner's interpretation in writing.

A.3.3 If the Contractor finds discrepancies in, or omissions from the Contract Documents, or if the Contractor is in doubt as to their meaning, the Contractor shall at once notify the Owner in writing. Matters concerning and interpretation of requirements of the Contract Documents will be decided by the Owner, who may delegate that duty in some instances to the Architect/Engineer. Responses to Contractor's requests for interpretation of Contract Documents will be made in writing by Owner (or the Architect/Engineer) within any time limits agreed upon or otherwise with reasonable promptness. Interpretations and decisions of the Owner (or Architect/Engineer) will be consistent with the intent of and reasonably inferable from the Contract Documents. Contractor shall not proceed without direction in writing from the Owner (or Architect/Engineer).

A.3.4 References to standard specifications, manuals, codes of any technical society, organization or association, to the laws or regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, laws or regulations in effect in the jurisdiction where the project is occurring on the first published date of the Solicitation Document, except as may be otherwise specifically stated.

A.4 EXAMINATION OF PLANS, SPECIFICATIONS, AND SITE

A.4.1 It is understood that the Contractor, before submitting an Offer, has made a careful examination of the Contract Documents; has become fully informed as to the quality and quantity of materials and the character of the Work required; and has made a careful examination of the location and conditions of the Work and the sources of supply for materials. The Owner will in no case be responsible for any loss or for any unanticipated costs that may be suffered by the Contractor as a result of the Contractor's failure to acquire full information in advance in regard to all conditions pertaining to the Work. No oral agreement or conversation with any officer, agent, or personnel of the Owner, or with the Architect/Engineer either before or after the e x e c u t i o n of this Contract, shall affect or modify any of the terms or obligations herein contained.

A.4.2 Should the Plans or Specifications fail to particularly describe the materials, kind of goods, or details of construction of any aspect of the Work, Contractor shall have the duty to make inquiry of the Owner and Architect/Engineer as to what is required prior to performance of the Work. Absent Specifications to the contrary, the materials or processes that would normally be used to produce first quality finished Work shall be considered a part of the Contract requirements.

A.4.3 Any design errors or omissions noted by the Contractor shall be reported promptly to the Owner and confirmed in writing, including without limitation, any nonconformity with Applicable Laws.

A.4.4 If the Contractor believes that adjustments to cost or Contract Time is involved because of clarifications or instructions issued by the Owner (or Architect/Engineer) in response to the Contractor's notices or requests for information, the Contractor must submit a written request to the Owner, setting forth the nature and specific extent of the request, including all time and cost impacts against the Contract as soon as possible, but no later than thirty (30) Days after receipt by Contractor of the clarifications or instructions issued. If the Owner denies Contractor's request for additional compensation, additional Contract Time, or other relief that Contractor believes results from the clarifications or instructions, the Contractor may proceed to file a Claim under Section D.3, Claims Review Process. If the Contractor fails to perform the obligations of Sections A.4.1 to A.4.3, the Contractor shall pay such costs and damages to the Owner as would have been avoided if the Contractor had performed such obligations.

A.5 INDEPENDENT CONTRACTOR STATUS

The service or services to be performed under this Contract are those of an independent contractor as defined in ORS 670.600.

Contractor represents and warrants that it is not an officer, employee or agent of the Owner as those terms are used in ORS 30.265.

A.6 RETIREMENT SYSTEM STATUS AND TAXES

Contractor represents and warrants that it is not a contributing member of the Public Employees' Retirement System and will be responsible for any federal or state taxes applicable to payment r e c e i v e d under this Contract. Contractor will not be eligible for any benefits from these Contract payments of federal Social Security, employment insurance, workers' compensation or the Public Employees' Retirement System, except as a self-employed individual. Unless the Contractor is subject to backup withholding, Owner will not withhold from such payments any amount(s) to cover Contractor's federal or state tax obligations.

A.7 GOVERNMENT EMPLOYMENT STATUS

A.7.1 If this payment is to be charged against federal funds, Contractor represents and warrants that it is not currently employed by the Federal Government. This does not preclude the Contractor f r o m holding another contract with the Federal Government.

A.7.2 Contractor represents and warrants that Contractor is not an employee of the State of Oregon for purposes of performing Work under this Contract

SECTION B
ADMINISTRATION OF THE CONTRACT

B.1 OWNER'S ADMINISTRATION OF THE CONTRACT

B.1.1 The Owner shall administer the Contract as described in the Contract Documents (1) during construction (2) until Final Payment is due and (3) during the one-year period for correction of Work. The Owner will act as provided in the Contract Documents, unless modified in writing in accordance with other provisions of the Contract. In performing these tasks, the Owner may rely on the Architect/Engineer or other consultants to perform some or all of these tasks.

B.1.2 The Owner will visit the site at intervals appropriate to the stage of the Contractor's operations (1) to become generally familiar with and to keep the Owner informed about the progress and quality of the portion of the Work completed, (2) to endeavor to guard the Owner against defects and deficiencies in the Work, and (3) to determine in general if Work is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. The Owner will not make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Owner will neither have control over or charge of, nor be responsible for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work. Inspection of the progress, quantity, or quality of the Work done by the Owner, any Owner representative, and public agency, the Architect/Engineer, or any inspector, shall not relieve the Contractor of any responsibility for the compliance of all Work with the Contract Documents.

B.1.3 Except as otherwise provided in the Contract Documents or when direct communications have been specifically authorized, the Owner and Contractor shall communicate with each other about matters arising out of or relating to the Contract. Communications by and with the Architect/Engineer's consultants shall be through the Architect/Engineer. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with separate contractors shall be through the Owner.

B.2 Based upon the Architect/Engineer's evaluations of the Contractor's Application for Payment, or unless otherwise stipulated by the Owner, the Architect/Engineer will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts. CONTRACTOR'S MEANS AND METHODS; MITIGATION OF IMPACTS

B.2.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the Contract Documents give other specific instructions concerning these matters. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences or procedures, the Contractor shall evaluate the jobsite safety thereof and, except as stated below, shall be fully and solely responsible for the jobsite safety of such means, methods, techniques, sequences or procedures.

B.2.2 The Contractor is responsible to protect and maintain the Work during the course of construction and to mitigate any adverse impacts to the project, including those caused by authorized changes, which may affect cost, schedule, or quality.

B.2.3 The Contractor is responsible for the actions of all its personnel, laborers, suppliers, and Subcontractors on the project. The Contractor shall enforce strict discipline and good order among Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of persons who are unfit or unskilled for the tasks assigned to them.

B.3 MATERIALS AND WORKMANSHIP

B.3.1 The intent of the Contract Documents is to provide for the construction and completion in every detail of the Work described. All Work shall be performed in a professional manner and unless the means or methods of performing a task are specified elsewhere in the Contract Documents, Contractor shall employ methods that are generally accepted and used by the industry, in accordance with industry standards.

B.3.2 The Contractor is responsible to perform the Work as required by the Contract Documents. Defective Work shall be corrected at the Contractor's expense.

B.3.3 Work done and materials furnished shall be subject to inspection and/or observation and testing by the Owner to determine if they conform to the Contract Documents. Inspection of the Work by the Owner does not relieve the Contractor of responsibility for the Work in accordance with the Contract Documents.

B.3.4 Contractor shall furnish adequate facilities, as required, for the Owner to have safe access to the Work including without limitation walkways, railings, ladders, tunnels, and platforms. Producers, suppliers, and fabricators shall also provide proper facilities and access to their

facilities.

B.3.5 The Contractor shall furnish Samples of materials for testing by the Owner and include the cost of the Samples in the Contract Price.

B.4 PERMITS

Contractor shall obtain and pay for all necessary permits, licenses and fees, except for those specifically excluded in the Supplemental General Conditions, for the construction of the Work, for temporary obstructions, enclosures, opening of streets for pipes, walls, utilities, environmental Work, etc., as required for the project.
Contractor shall be responsible for all violations of the law, in connection with the construction or caused by obstructing streets, sidewalks or otherwise. Contractor shall give all requisite notices to public authorities.

B.5 COMPLIANCE WITH GOVERNMENT REGULATIONS

B.5.1 Contractor shall comply with Applicable Laws pertaining to the Work and the Contract. Failure to comply with such requirements shall constitute a breach of Contract and shall be grounds for Contract termination. Without limiting the generality of the foregoing, Contractor expressly agrees to comply with the following, as applicable: (i) Title VI and VII of Civil Rights Act of 1964, as amended; (ii) Section 503 and 504 of the Rehabilitation Act of 1973, as amended; (iii) the Health Insurance Portability and Accountability Act of 1996; (iv) the Americans with Disabilities Act of 1990, as amended; (v) ORS Chapter 659; as amended; (vi) ORS Chapter 659A; as amended; (vii) all regulations and administrative rules established pursuant to the foregoing laws; and (vii) all other applicable requirements of federal and state civil rights and rehabilitation statutes, rules and regulations.

B.5.2 Contractor shall comply with all applicable requirements of federal and state civil rights and rehabilitation statutes, rules and regulations, and

(a) Contractor shall not discriminate against Disadvantaged, Minority, Women or Emerging Small Business enterprises, as those terms are defined in ORS 200.005, or a business enterprise that is owned or controlled by or that employs a disabled veteran, as that term is defined in ORS 408.225, in the awarding of subcontracts.

(b) Contractor shall maintain, in current and valid form, all licenses and certificates required by Applicable Laws or this Contract when performing the Work.

B.5.3 Unless contrary to federal law, Contractor shall certify that it shall not accept a bid from Subcontractors to perform Work as described in ORS 701.005 under this Contract unless such Subcontractors are registered with the Construction Contractors Board in accordance with ORS 701.021 to 701.068 at the time they submit their bids to the Contractor.

B.5.4 Unless contrary to federal law, Contractor shall certify that each landscape contractor, as defined in ORS 671.520(2), performing Work under this Contract holds a valid landscape contractor's license issued pursuant to ORS 671.560.

B.5.5 The following notice is applicable to Contractors who perform excavation Work. ATTENTION: Oregon law requires you to follow rules adopted by the Oregon Utility Notification Center. Those rules are set forth in OAR 952-001-0010 through OAR 952-001-00100. You may obtain copies of the rules by calling the center at (503)232-1987.

B.5.6 Failure to comply with any or all of the requirements of B.5.1 through B.5.5 shall be a breach of Contract and constitute grounds for Contract termination. Damages or costs resulting from such noncompliance shall be the responsibility of Contractor.

B.6 SUPERINTENDENCE

Contractor shall keep on the site, during the progress of the Work, a competent superintendent and any necessary assistants who shall be satisfactory to the Owner and who shall represent the Contractor on the site. Directions given to the superintendent by the Owner shall be confirmed in writing to the Contractor.

B.7 INSPECTION

B.7.1 Owner shall have access to the Work at all times.

B.7.2 Inspection of the Work will be made by the Owner at its discretion. The Owner will have authority to reject Work that does not conform to the Contract Documents. Any Work found to be not in conformance with the Contract Documents, in the discretion of the Owner, shall be removed and replaced at the Contractor's expense.

B.7.3 Contractor shall make or obtain at the appropriate time all tests, inspections and approvals of portions of the Work required by the Contract Documents or by Applicable Laws or orders of public authorities having jurisdiction. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections and approvals. Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work. The Contractor shall give the Owner timely notice of when and where tests and inspections are to be made so that the Owner may be present for such procedures. Required certificates of testing, inspection or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Owner.

B.7.4 As required by the Contract Documents, Work done or material used without required inspection or testing and/or without providing timely notice to the Owner may be ordered removed at the Contractor's expense.

B.7.5 If directed to do so any time before the Work is accepted, the Contractor shall uncover portions of the completed Work for inspection. After inspection, the Contractor shall restore such portions of Work to the standard required by the Contract. If the Work uncovered is unacceptable or was done without required testing or inspection or sufficient notice to the Owner, the uncovering and restoration shall be done at the Contractor's expense. If the Work uncovered is acceptable and was done with sufficient notice to the

Owner, the uncovering and restoration will be paid for pursuant to an Amendment.

B.7.6 If any testing or inspection reveals failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Owner's and Architect/Engineer's services and expenses, shall be at the Contractor's expense.

B.7.7 When the United States government participates in the cost of the Work, or the Owner has an agreement with other public or private organizations, or if any portion of the Work is being performed for a third party or in close proximity to third party facilities, representatives of these organizations shall have the right to inspect the Work affecting their interests or property. Their right to inspect shall not make them a party to the Contract and shall not interfere with the rights of the parties of the Contract. Instructions or orders of such parties shall be transmitted to the Contractor, through the Owner.

B.8 SEVERABILITY

If any provision of this Contract is declared by a court to be illegal or in conflict with any law, the validity of the remaining terms and provisions shall not be affected and the rights and obligations of the parties shall be construed and enforced as if the Contract did not contain the particular provision held to be invalid.

B.9 ACCESS TO RECORDS

B.9.1 Contractor shall keep, at all times on the Work site, one record copy of the complete Contract Documents, including the Plans, Specifications, Construction Change Directives and addenda, in good order and marked currently to record field changes and selections made during construction, and one record copy of

Shop Drawings, Product Data, Samples and similar Submittals, and shall at all times give the Owner access thereto.

B.9.2 Contractor shall retain and the Owner and its duly authorized representatives shall have access, for a period not less than ten (10) years, to all Record Documents, financial and accounting records, and other books, documents, papers and records of Contractor which are pertinent to the Contract, including records pertaining to Overhead and indirect costs, for the purpose of making audit, examination, excerpts and transcripts. If for any reason, any part of the Work or this Contract shall be subject to litigation, Contractor shall retain all such records until all litigation is resolved and Contractor shall continue to provide Owner and/or its agents with full access to such records until such time as all litigation is complete and all periods for appeal have expired and full and final satisfaction of any judgment, order or decree is recorded and Owner receives a record copy of documentation from Contractor.

B.10 WAIVER

Failure of the Owner to enforce any provision of this Contract shall not constitute a waiver or relinquishment by the Owner of the right to such performance in the future nor of the right to enforce any other provision of this Contract.

B.11 SUBCONTRACTS AND ASSIGNMENT

B.11.1 Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound by the terms and conditions of these Public Improvement General Conditions, and to assume toward the Contractor all of the obligations and responsibilities which the Contractor assumes toward the Owner thereunder, unless (1) the same are clearly inapplicable to the subcontract at issue because of legal requirements or industry practices, or (2) specific exceptions are requested by Contractor and approved in writing by Owner. Where appropriate, Contractor shall require each Subcontractor to enter into similar agreements with sub-subcontractors at any level.

B.11.2 At Owner's request, Contractor shall submit to Owner prior to their execution either Contractor's form of subcontract, or the subcontract to be executed with any particular Subcontractor. If Owner disapproves such form, Contractor shall not execute the form until the matters disapproved are resolved to Owner's satisfaction. Owner's review, comment upon or approval of any such form shall not relieve Contractor of its obligations under this Agreement or be deemed a waiver of such obligations of Contractor.

B.11.3 Contractor shall not assign, sell, or transfer its rights, or delegate its responsibilities under this Contract, in whole or in part, without the prior written approval of the Owner. No such written approval shall relieve Contractor of any obligations of this Contract, and any transferee shall be considered the agent of the Contractor and bound to perform in accordance with the Contract Documents. Contractor shall remain liable as between the original parties to the Contract as if no assignment had occurred.

B.12 SUCCESSORS IN INTEREST

The provisions of this Contract shall be binding upon and shall accrue to the benefit of the parties to the Contract and their respective permitted successors and assigns.

B.13 OWNER'S RIGHT TO DO WORK

Owner reserves the right to perform other or additional work at or near the project site with other forces than those of the Contractor. If such work takes place within or next to the project site, Contractor shall coordinate work with the other contractors or forces, cooperate with all other contractors or forces, carry out the Work in a way that will minimize interference and delay for all forces involved, place and dispose of materials being used so as not to interfere with the operations of another, and join the Work with the work of the others in an acceptable manner and perform it in proper sequence to that of the others. The Owner will resolve any disagreements that may arise between or among Contractor and the other contractors over the method or order of doing all work (including the Work). In case of unavoidable interference, the Owner will establish work priority (including the Work) which generally will be in the sequence that the contracts were awarded.

B.14 OTHER CONTRACTS

In all cases and at any time, the Owner has the right to execute other contracts related to or unrelated to the Work of this

Contract. The Contractor of this Contract shall fully cooperate with any and all other contractors without additional cost to the Owner in the manner described in section B.13.

B.15 GOVERNING LAW

This Contract shall be governed by and construed in accordance with the laws of the State of Oregon without regard to principles of conflict of laws.

B.16 LITIGATION

Any Claim between Owner and Contractor that arises from or relates to this Contract and that is not resolved through the Claims Review Process in Section D.3 shall be brought and conducted solely and exclusively within the Circuit Court of Benton County for the State of Oregon; provided, however, if a Claim must be brought in a federal forum, then it shall be brought and conducted solely and exclusively within the United States District Court for the District of Oregon. In no event shall this section be construed as a waiver by the State of Oregon on any form of defense or immunity, whether sovereign immunity, governmental immunity, immunity based on the Eleventh Amendment to the Constitution of the United States or otherwise, from any claim or from the jurisdiction of any court. CONTRACTOR, BY EXECUTION OF THIS CONTRACT, HEREBY CONSENTS TO THE IN PERSONAM JURISDICTION OF THE COURTS REFERENCED IN THIS SECTION B.16.

B.17 ALLOWANCES

B.17.1 The Contractor shall include in the Contract Price all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct.

B.17.2 Unless otherwise provided in the Contract Documents:

(a) when finally reconciled, allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;

(b) Contractor's costs for unloading and handling at the site, labor, installation costs, Overhead, profit and other expenses contemplated for stated allowance amounts shall be included in the Contract Price but not in the allowances;

(c) whenever costs are more than or less than allowances, the Contract Price shall be adjusted accordingly by Amendment. The amount of the Amendment shall reflect
(i) the difference between actual costs and the allowances under Section B.17.2(a) and (2) changes in Contractor's costs under Section B.17.2(b).

(d) Unless Owner requests otherwise, Contractor shall provide to Owner a proposed fixed price for any allowance work prior to its performance.

B.18 SUBMITTALS, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

B.18.1 The Contractor shall prepare and keep current, for the Architect's/Engineer's approval (or for the approval of Owner if approval authority has not been delegated to the Architect/Engineer), a schedule and list of Submittals which is coordinated with the Contractor's construction schedule and allows the Architect/Engineer reasonable time to review Submittals. Owner reserves the right to finally approve the schedule and list of Submittals. Submittals include, without limitation, Shop Drawings, product data, and samples which are described below:

(a) Shop Drawings are drawings, diagrams, schedules and other data specially prepared for the Work by the Contractor or a Subcontractor (including any sub-subcontractor), manufacturer, supplier or distributor to illustrate some portion of the Work.

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

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

B.18.2 Shop Drawings, Product Data, Samples and similar Submittals are not Contract Documents. The purpose of their Submittal is to demonstrate for those portions of the Work for which Submittals are required by the Contract Documents the way by which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents. Review of Submittals by the Architect/Engineer is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, or for approval of safety precautions or, unless otherwise specifically stated by the Architect/Engineer, of any construction means, methods, techniques, sequences or procedures, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect/Engineer's review of the Contractor's Submittals shall not relieve the Contractor of its obligations under the Contract Documents. The Architect/Engineer's approval of a specific item shall not indicate approval of an assembly of which the item is a component. Informational Submittals upon which the Architect/Engineer is not expected to take responsive action may be so identified in the Contract Documents. Submittals which are not required by the Contract Documents may be returned by the Architect/Engineer without action.

B.18.3 The Contractor shall review for compliance with the Contract Documents, approve and submit to the Architect/Engineer Shop Drawings, Product Data, Samples and similar Submittals required by the Contract Documents with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate contractors. Submittals which are not marked as reviewed for compliance with the Contract Documents and approved by the Contractor may be returned by the Architect/Engineer without action.

B.18.4 Approving and submitting shop drawings, product data, samples and similar Submittals, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and has checked and coordinated the information contained within such Submittals with the requirements of the Work and of the Contract Documents.

B.18.5 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples or similar Submittals until the respective Submittal has been approved by the Architect/Engineer.

B.18.6 The Work shall be in accordance with approved Submittals except that the Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect/Engineer's review or approval of Shop Drawings, Product Data, Samples or similar Submittals unless the Contractor has specifically informed the Architect/Engineer in writing of such deviation at the time of submittal and (i) the Architect/Engineer has given written approval to the specific deviation as a minor change in the Work, or (ii) an Amendment or Construction Change Directive has been executed by Owner authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar Submittals by the Architect/Engineer's review or approval thereof.

B.18.7 In the event that Owner elects not to have the obligations and duties described under this Section B.18 performed by the Architect/Engineer, or in the event no Architect/Engineer is employed by Owner on the project, all obligations and duties assigned to the Architect/Engineer hereunder shall be performed by the Owner.

B.19 SUBSTITUTIONS

The Contractor may make Substitutions only with the written consent of the Owner, after evaluation by the Owner and only in accordance with an Amendment or Construction Change Directive. Substitutions shall be subject to the requirements of the bid documents. By making requests for Substitutions, the Contractor: represents that the Contractor has personally investigated the proposed substitute product; represents that the Contractor will provide the same warranty for the Substitution that the Contractor would for the product originally specified unless approved otherwise; certifies that the cost data presented is complete and includes all related costs under this Contract including redesign costs, and waives all claims for additional costs related to the Substitution which subsequently become apparent; and will coordinate the installation of the accepted Substitution, making such changes as may be required for the Work to be completed in all respects.

B.20 USE OF PLANS AND SPECIFICATIONS

Plans, Specifications and related Contract Documents furnished to Contractor by Owner or Owner's Architect/Engineer shall be used solely for the performance of the Work under this Contract. Contractor and its Subcontractors and suppliers are authorized to use and r e p r o d u c e applicable portions of such documents appropriate to the execution of the Work, but shall not claim any ownership or other interest in them beyond the scope of this Contract, and no such interest shall attach. Unless otherwise indicated, all common law, statutory and terminate the Contract.

B.21 FUNDS AVAILABLE AND AUTHORIZED

If Owner fails to receive funding, appropriations, allocations or other expenditure authority as contemplated by Owner's budget and Owner determines, in its assessment and ranking of the policy objectives explicit or implicit in Owner's budget, Owner may other reserved rights, in addition to copyrights, are retained by Owner.

B.22 NO THIRD PARTY BENEFICIARIES

Owner and Contractor are the only parties to this Contract and are the only parties entitled to enforce its terms. Nothing in this Contract gives, is intended to give, or shall be construed to give or provide any benefit or right, whether directly, indirectly, or otherwise, to third persons unless such third persons are individually identified by name herein and expressly described as intended beneficiaries of the terms of this Contract.

SECTION C
WAGES AND LABOR

C.1 MINIMUM WAGE RATES ON PUBLIC WORKS

Contractor shall comply fully with the provisions of ORS 279C.800 through 279C.870. Documents establishing those conditions, as determined by the Commissioner of the Bureau of Labor and Industries (BOLI), are included as attachments to or are incorporated by reference in the Contract Documents. Pursuant to ORS 279C.830(1)(c), Contractor shall pay workers at not less than the specified minimum hourly rate of wage, and shall include that requirement in all subcontracts. If the Work is subject to both the state prevailing wage rate law and the federal Davis-Bacon Act, Contractor shall pay the higher of the applicable state or federal prevailing rate of wage. Contractor shall provide written notice to all workers of the number of hours per day and days per week such workers may be required to work.

C.2 PAYROLL CERTIFICATION AND FEE REQUIREMENTS

C.2.1 In accordance with ORS 279C.845, the Contractor and every Subcontractor shall submit written certified statements to the Owner, on the form prescribed by the Commissioner of the Bureau of Labor and Industries, certifying the hourly rate of wage paid each worker which the Contractor or the Subcontractor has employed on the project and further certifying that no worker employed on the project has been paid less than the prevailing rate of wage or less than the minimum hourly rate of wage specified in the Contract, which certificate and statement shall be verified by the oath of the Contractor or the Subcontractor that the Contractor or Subcontractor has read the certified statement, that the Contractor or Subcontractor knows the contents of the certified statement, and, that to the Contractor's or Subcontractor's best knowledge and belief, the certified statement is true. The certified statements shall set out accurately and completely the payroll records for the prior week, including the name and address of each worker, the worker's correct classification, rate of pay, daily and weekly number of

hours worked, deductions made, and actual wages paid. Certified statements for each week during which the Contractor or Subcontractor has employed a worker on the project shall be submitted once a month, by the fifth business day of the following month. The Contractor and Subcontractors shall preserve the certified statements for a period of ten (10) years from the date of completion of the Contract.

C.2.2 Pursuant to ORS 279C.845(7), the Owner shall retain 25 percent of any amount earned by the Contractor on this public works project until the Contractor has filed the certified statements required by section C.2.1. The Owner shall pay to the Contractor the amount retained under this subsection within 14 days after the Contractor files the required certified statements, regardless of whether a Subcontractor has failed to file certified statements. Pursuant to ORS 279C.845(8), the Contractor shall retain 25 percent of any amount earned by a first-tier Subcontractor on this public works project until the first-tier Subcontractor has filed with the Owner the certified statements required by C.2.1. Before paying any amount retained under this subsection, the Contractor shall verify that the first-tier Subcontractor has filed the certified statement. Within 14 days after the first-tier Subcontractor files the required certified statement the Contractor shall pay the first-tier Subcontractor any amount retained under this subsection.

C.2.3 In accordance with statutory requirements and administrative rules promulgated by the Commissioner of the Bureau of Labor and Industries, the fee required by ORS 279C.825(1) will be paid by Owner to the Commissioner.

C.3 PROMPT PAYMENT AND CONTRACT CONDITIONS

C.3.1 As a condition to Owner's performance hereunder, the Contractor shall:

C.3.1.1 Make payment promptly, as due, to all persons supplying to Contractor labor or materials for the prosecution of the Work provided for in this Contract.

C.3.1.2 Pay all contributions or amounts due the State Industrial Accident Fund from such Contractor or Subcontractor incurred in the performance of the Contract.

C.3.1.3 Not permit any lien or claim to be filed or prosecuted against the Owner on account of any labor or material furnished. Contractor will not assign any claims that Contractor has against Owner, or assign any sums due by Owner, to Subcontractors, suppliers, or manufacturers, and will not make any agreement or act in any way to give Subcontractors a claim or standing to make a claim against the Owner.

C.3.1.4 Pay to the Department of Revenue all sums withheld from employees pursuant to ORS 316.167.

C.3.2 As a condition to Owner's performance hereunder, if Contractor fails, neglects or refuses to make prompt payment of any claim for labor or services furnished to the Contractor of a Subcontractor by any person in connection with the project as such claim becomes due, the proper officer(s) representing the Owner may pay the claim and charge the amount of the payment against funds due or to become due Contractor under this Contract. Payment of claims in this manner shall not relieve the Contractor or the Contractor's surety from obligation with respect to any unpaid claims.

C.3.3 Contractor shall include in each subcontract for property or services entered into by the Contractor and a first-tier subcontractor, including a material supplier, for the purpose of performing a construction contract, a payment clause that obligates the Contractor to pay the first-tier Subcontractor for satisfactory performance under its subcontract within ten (10) Days out of such amounts as are paid to the Contractor by the public contracting agency under such contract.

C.3.4 All employers, including Contractor, that employ subject workers who work under this contract in the State of Oregon shall comply with ORS 656.017 and provide the required Workers' Compensation coverage, unless such employers are exempt under ORS 656.126. Contractor shall ensure that each of its Subcontractors complies with these requirements.

C.4 PAYMENT FOR MEDICAL CARE

As a condition to Owner's performance hereunder, Contractor shall promptly, as due, make payment to any person, partnership, association or corporation furnishing medical, surgical, and hospital care or other needed care and attention, incident to sickness or injury, to the employees of such Contractor, all sums of which the Contractor agrees to pay for such services and all moneys and sums which the Contractor has collected or deducted from the wages of personnel pursuant to any law, contract or agreement for the purpose of providing or paying for such services.

C.5 HOURS OF LABOR

As a condition to Owner's performance hereunder, no person shall be employed to perform Work under this Contract for more than ten (10) hours in any one day or forty (40) hours in any one week, except in cases of necessity, emergency or where public policy absolutely requires it. In such instances, Contractor shall pay the employee at least time and a half pay:

(a) For all overtime in excess of eight (8) hours a day or forty (40) hours in any one week when the work week is five consecutive Days, Monday through Friday; or

(b) For all overtime in excess of ten (10) hours a day or forty (40) hours in any one week when the work week is four consecutive Days, Monday through Friday; and

(c) For all Work performed on Saturday and on any legal holiday specified in ORS 279C.540.

This section C.5 will not apply to Contractor's Work under this Contract to the extent Contractor is currently a party to a collective bargaining agreement with any labor organization.

This Section C.5 shall not excuse Contractor from completion of the Work within the time required under this Contract.

SECTION D
CHANGES IN THE WORK

D.1 CHANGES IN WORK

D.1.1 The terms of this Contract shall not be waived, altered, modified, supplemented or amended in any manner whatsoever, without prior written agreement and then only after any necessary approvals have been obtained. An Amendment or Change Order is required, which shall not be effective until its execution by the parties to this Contract and all approvals required by public contracting laws have been obtained.

D.1.2 It is mutually agreed that changes in Plans, quantities, or details of construction are inherent in the nature of construction and may be necessary or desirable during the course of construction. Within the general scope of this Contract, the Owner may at any time, without notice to the sureties and without impairing the Contract, require changes consistent with this Section D.1. All changes to the Work shall be documented and Amendments shall be executed under the conditions of the Contract Documents. Such changes may include, but are not limited to:

(a) Modification of specifications and design.
(b) Increases or decreases in quantities.
(c) Increases or decreases to the amount of Work.
(d) Addition or elimination of any Work item.
(e) Change in the duration of the project.
(f) Acceleration or delay in performance of Work.
(g) Deductive changes,
(h) Changed conditions.

Deductive changes are those that reduce the scope of the Work, and shall be made by mutual agreement whenever feasible. In cases of suspension or partial termination under Section J, Owner reserves the right to unilaterally impose a deductive change and to self-perform such Work, for which the provisions of B.13 (Owner's Right to Do Work) shall then apply. Adjustments in compensation shall be made under the provisions of D.1.3, in which costs for deductive changes shall be based upon a Direct Costs adjustment together with the related percentage markup specified for profit, Overhead and other indirect costs, unless otherwise agreed to by Owner.

D.1.3 The Owner and Contractor agree that adjustments to or deletions from the Work shall be administered and compensated according to the following:

(a) Unit pricing may be utilized at the Owner's option when unit prices or solicitation alternates were provided that established the cost for adjustments to Work, and a binding obligation exists under the Contract on the parties covering the terms and conditions of the adjustment to Work.

(b) If the Owner elects not to utilize unit pricing, or in the event that unit pricing is not available or appropriate, fixed pricing may be used for adjustments to or deletions from the Work. In fixed pricing, the basis of payments or total price shall be agreed upon in writing between the parties to the Contract, and shall be established before the Work is done whenever feasible. Notwithstanding the foregoing, the mark-ups set forth in D.1.3(c) shall be utilized in establishing fixed pricing, and such mark-ups shall not be exceeded. Cost and price data relating to adjustments to or deletions from the Work shall be supplied by Contractor to Owner upon request, but Owner shall be under no obligation to make such requests.

(c) In the event that unit pricing and fixed pricing are not utilized, then adjustments to or deletions from the Work shall be performed on a cost reimbursement basis for Direct Costs. Such Work shall be compensated on the basis of the actual, reasonable and allowable cost of labor, equipment, and material furnished on the Work performed. In addition, the following markups shall be added to the Contractor's or Subcontractor's Direct Costs as full compensation for profit, Overhead and other indirect costs for Work directly performed with the Contractor's or Subcontractor's own forces:

On Labor.....	15%
On Equipment.....	10%
On Materials.....	10%

(d) When adjustments to or deletions from the Work under D.1.3(c) are invoiced by an authorized Subcontractor at any level, each ascending tier Subcontractor or Contractor will be allowed a supplemental mark-up on each piece of subcontract Work covered by an Amendment as follows:

$0.00 - $5,000.00 10%,
and then Over $5,000.00
5%

Notwithstanding the foregoing, the maximum aggregate markup to be billed shall not exceed 10% regardless of the number of Subcontract tiers.

Payments made to the Contractor shall be complete compensation for Overhead, profit, and all costs that were incurred by the Contractor or by other forces furnished by the Contractor, including Subcontractors, for adjustments to or deletions from the Work pursuant to an Amendment or Change Order. Owner may establish a maximum cost for additional Work under this Section D.1.3, which shall not be exceeded for reimbursement without additional written authorization from Owner in the form of an Amendment or Change Order. Contractor shall not be required to complete such additional Work without additional authorization.

D.1.4 Any necessary adjustment of Contract Time that may be required as a result of adjustments to or deletions from the Work must be agreed upon by the parties before the start of the revised Work unless Owner authorizes Contractor to start the revised Work before agreement on Contract Time adjustment. Contractor shall submit any request for additional compensation (and additional Contract Time if Contractor was authorized to start Work before an adjustment of Contract Time was approved) as soon as possible but no later than thirty (30) Days after receipt of Owner's request for additional Work. Contractor agrees that this thirty (30) Day notice period is adequate time for it to request and document the amount of additional compensation or adjustment of Contract Time. If Contractor's request for additional compensation or adjustment of Contract Time is not made within the

thirty (30) Day time limit, Contractor agrees its requests pertaining to that additional Work shall be barred. The thirty (30) Day time limit for making requests shall not be extended for any reason, including without limitation Contractor's claimed inability to determine the amount of additional compensation or adjustment of Contract Time, unless an extension is granted in writing by Owner. If the Owner denies Contractor's timely request for additional compensation or adjustment of Contract Time, Contractor may proceed to file a Claim under Section D.3, Claims Review Process. No other reimbursement, compensation, or payment will be made, except as provided in Section D.1.5 for impact claims.

D.1.5 If any adjustment to Work under Section D.1.3 causes an increase or decrease in the Contractor's cost of, or the Contract Time required for the performance of any other part of the Work under this Contract, Contractor shall submit a written request to the Owner, setting forth the nature and specific extent of the request, including all time and cost impacts against the Contract as soon as possible, but no later than thirty (30) Days after receipt of Owner's request for adjustments to or deletions from the Work by Contractor.

The thirty (30) Day time limit applies to claims of Subcontractors, suppliers, or manufacturers who may be affected by Owner's request for adjustments to or deletions from the Work and who request additional compensation or an extension of Contract Time to perform; Contractor has responsibility for contacting its Subcontractors, suppliers, or manufacturers within the thirty (30) Day time limit, and including their requests with Contractor's requests. If the request involves Work to be completed by Subcontractors, or materials to be furnished by suppliers or manufacturers, such requests shall be submitted to the Contractor in writing with full analysis and justification for the adjustments to compensation and Contract Time requested. The Contractor shall analyze and evaluate the merits of the requests submitted by Subcontractors, suppliers, and manufacturers to Contractor prior to including those requests and Contractor's analysis and evaluation of those requests with Contractor's requests for adjustments to compensation or Contract Time that Contractor submits to the Owner. Failure of Subcontractors, suppliers, manufacturers or others to submit their requests to Contractor for inclusion with Contractor's requests submitted to Owner within the time period and by the means described in this section shall constitute a waiver of these Subcontractor claims. The Owner will not consider direct requests or claims from Subcontractors, suppliers, manufacturers or others not a party to this Contract. The consideration of such requests and claims under this section does not give any Person, not a party to the Contract the right to bring a claim against Owner, whether in this claims process, in litigation, or in any dispute resolution process.

If the Owner denies the Contractor's request for adjustment to compensation or Contract Time and the request is timely as set forth herein, the Contractor may proceed to file a Claim under Section D.3, Claims Review Process.

D.1.6 Contractor agrees that no request or Claim for additional costs or an adjustment of Contract Time shall be allowed if made after receipt of Final Payment application under this Contract. Final Payment application must be made by Contractor within the time required under Section E.6.4.

D.1.7 It is understood that changes in the Work are inherent in construction of this type. The number of changes, the scope of those changes, and the effect they have on the progress of the original Work cannot be defined at this time. The Contractor is notified that numerous changes may be required and that there will be no compensation made, unless and only to the extent otherwise provided in the Contract Documents, to the Contractor directly related to the number of changes. Each change will be evaluated for extension of Contract Time and increase or decrease in compensation based on its own merit.

D.2 DELAYS

D.2.1 Delays in construction include "Avoidable Delays", which are defined in Section D.2.1.1, and "Unavoidable Delays", which are defined in Section D.2.1.2. The effect of Avoidable Delays is described in Section D.2.2 and the effect of Unavoidable Delays is described in Section D.2.3.

D.2.1.1 Avoidable Delays include any delays other than Unavoidable Delays, and include delays that otherwise would be considered Unavoidable Delays but that:

(a) Could have been avoided by the exercise of care, prudence, foresight, and diligence on the part of the Contractor or its Subcontractors.

(b) Affect only a portion of the Work and do not necessarily prevent or delay the prosecution of other parts of the Work or the completion of the whole Work within the Contract Time.

(c) Do not impact activities on the accepted CPM Construction Schedule.

(d) Are associated with the reasonable interference of other contractors employed by the Owner that do not necessarily prevent the completion of the whole Work within the Contract Time.

D.2.1.2 Unavoidable Delays include delays other than Avoidable Delays that are:

(a) To the extent caused by any actions of the Owner, or any other employee or agent of the Owner, or by separate contractor employed by the Owner.

(b) To the extent caused by any site conditions that differ materially from what was represented in the Contract Documents or from conditions that would normally be expected to exist and be inherent to the construction activities defined in the Contract Documents. The Contractor agrees to notify the Owner immediately of differing site conditions before the area has been disturbed. The Owner will investigate the area and make a determination as to whether the conditions differ materially from either the conditions stated in the Contract Documents or those that could reasonably be expected in execution of this particular Contract. If Contractor and the Owner agree that a differing site condition exists, any adjustment to compensation or Contract Time will be determined based on the process set forth in Section D.1.5 for adjustments to or deletions from Work. If the Owner disagrees that a differing site

condition exists and denies Contractor's request for additional compensation or Contract Time, Contractor may proceed to file a Claim under Section D.3, Claims Review Process.

(c) To the extent caused by Force Majeure acts, events or occurrences that could not have been avoided by the exercise of care, prudence, foresight, and diligence on the part of the Contractor or its Subcontractors.

(d) To the extent caused by adverse weather conditions. Any adverse weather conditions must be substantiated by documentary evidence that weather conditions were abnormal for the specific time period claimed, could not have been anticipated by the Contractor, and adversely impacted the Project in a manner that could not be avoided by rescheduling the Work or by implementing measures to protect against the weather so that the Work could proceed. A rain, windstorm, high water, or other natural phenomenon for the specific locality of the Work, which might reasonably have been anticipated from the previous 10-year historical records of the general locality of the Work, shall not be construed as abnormal. The parties agree that rainfall greater than the following levels cannot be reasonably anticipated:

(i) Daily rainfall equal to, or greater than, 0.50 inch during a month when the monthly rainfall exceeds the normal monthly average by twenty- five percent (25 %) or more.

(ii) daily rainfall equal to, or greater than, 0.75 inch at any time.

The Office of the Environmental Data Service of the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce nearest the Project site shall be considered the official agency of record for weather information.

D.2.2 Contractor agrees it is not entitled to additional compensation or additional Contract Time for Avoidable Delays.

D.2.3 In the event of Unavoidable Delays, based on principles of equitable adjustment, Contractor may be entitled to the following:

(a) Contractor may be entitled to additional compensation or additional Contract Time, or both, for Unavoidable Delays described in Section D.2.1.2 (a) and (b).

(b) Contractor may be entitled to additional Contract Time for Unavoidable Delays described in Section D.2.1.2(c) and (d).

In the event of any requests for additional compensation or additional Contract Time, or both, as applicable, arising under this Section D.2.3 for Unavoidable Delays, other than requests for additional compensation or additional Contract Time for differing site conditions for which a review process is established under Section D.2.1.2 (b), Contractor must submit a written notification of the delay to the Owner within two (2) Days of the occurrence of the cause of the delay. This written notification shall state the cause of the potential delay, the project components impacted by the delay, and the anticipated additional Contract Time extension or the additional compensation, or both, as applicable, resulting from the delay. Within seven (7) Days after the cause of the delay has been mitigated, or in no case more than thirty (30) Days after the initial written notification, the Contractor agrees to submit to the Owner, a complete and detailed request for additional compensation or additional Contract Time, or both, as applicable, resulting from the delay. If the Owner denies Contractor's request for additional compensation or adjustment of Contract Time, the Contractor may proceed to file a Claim under Section D.3, Claims Review Process, provided Contractor has complied with the requirement in this Section D.2.3. Contractor agrees any Claim it may have is barred if Contractor does not comply with the requirements herein.

If Contractor does not timely submit the notices required under this Section D.2, then unless otherwise prohibited by law, Contractor's Claim shall be barred.

D.3 CLAIMS REVIEW PROCESS

D.3.1 All Contractor Claims shall be referred to the Owner for review. Contractor's Claims, including Claims for adjustments to compensation or Contract Time, shall be submitted in writing by Contractor to the Owner within five (5) Days after a denial of Contractor's initial request for an adjustment of Contract terms, payment of money, extension of Contract Time or other relief, provided that such initial request has been submitted in accordance with the requirements and within the time limits established in these Public Improvement General Conditions.
Within thirty (30) Days after the initial Claim, Contractor shall submit to the Owner a complete and detailed description of the Claim (the "Detailed Notice") that includes all information required by Section D.3.2.
Contractor agrees that, unless the Claim is made in accordance with these time requirements, Contractor voluntarily waived all rights to prosecute its Claim.

D.3.2 The Detailed Notice of the Claim shall be submitted in writing by Contractor and shall include a detailed, factual statement of the basis of the Claim, pertinent dates, Contract provisions which support or allow the Claim, reference to or copies of any documents which support the Claim, the dollar value of the Claim, and the Contract Time adjustment requested for the Claim. If the Claim involves Work to be completed by Subcontractors, the Contractor will analyze and evaluate the merits of the Subcontractor claim prior to forwarding it and that analysis and evaluation to the Owner. The Owner will not consider direct claims from Subcontractors, suppliers, manufacturers, or others not a party to this Contract. Contractor agrees that it will make no agreement, covenant, or assignment, nor will it commit any other act that will permit or assist any Subcontractor, supplier, manufacturer, or other to directly or indirectly make a claim against Owner.

D.3.3 The Owner will review all Claims and take one or more of the following preliminary actions within ten (10) Days of receipt of the Detailed Notice of a Claim: (1) request additional supporting information from the Contractor; (2) inform the Contractor and Owner in writing of the time required for adequate review and response; (3) reject the Claim in whole or in part and identify the reasons for rejection; (4) based on principles of equitable adjustment,

recommend approval of all or part of the Claim; or
(5) propose an alternate resolution.

D.3.4 The Owner's decision shall be final and binding on the Contractor unless appealed by written notice to the Owner within fifteen (15) Days of receipt of the decision. The Contractor must present written documentation supporting the Claim within fifteen (15) Days of the notice of appeal. After receiving the appeal documentation, the Owner shall review the materials and render a decision within thirty (30) Days after receiving the appeal documents.

D.3.5 The decision of the Owner shall be final and binding unless the Contractor delivers to the Owner its request for mediation, which shall be a non-binding process, within fifteen (15) Days of the date of the Owner's decision. The mediation process will be considered to have commenced as of the date the Contractor delivers the request. Both parties acknowledge and agree that participation in mediation is a prerequisite to commencement of litigation of any disputes relating to the Contract. Both parties further agree to exercise their best efforts in good faith to resolve all disputes within sixty (60) Days of the commencement of the mediation through the mediation process set forth herein.

In the event that a lawsuit must be filed within this sixty (60) Day period in order to preserve a cause of action, the parties agree that, notwithstanding the filing, they shall proceed diligently with the mediation to its conclusion prior to actively prosecuting the lawsuit, and shall seek from the Court in which the lawsuit is pending such stays or extensions, including the filing of an answer, as may be necessary to facilitate the mediation process. Further, in the event settlements are reached on any issues through mediation, the plaintiff shall promptly cause to be entered by the Court a stipulated general judgment of dismissal with prejudice, or other appropriate order limiting the scope of litigation as provided in the settlement.

D.3.6 Should the parties arrive at an impasse regarding any Claims or disputed Claims, it is agreed that the parties shall participate in mediation as specified in Section D.3.5. The mediation process will be considered to have been commenced as of the date one party delivers to the other its request in writing to mediate. The mediator shall be an individual mutually acceptable to both parties, but in the absence of agreement each party shall select a temporary mediator and the temporary mediators shall jointly select the permanent mediator. Each party shall pay its own costs for the time and effort involved in mediation. The cost of the mediator shall be split equally between the two parties. Both parties agree to exercise their best effort in good faith to resolve all disputes in mediation. Participation in mediation is a mandatory requirement of both the Owner and the Contractor. The schedule, time and place for mediation will be mutually acceptable, or, failing mutual agreement, shall be as established by the mediator. The parties agree to comply with Owner's administrative rules governing the confidentiality of mediation, if any, and shall execute all necessary documents to give effect to such confidentiality rules. In any event, the parties shall not subpoena the mediator or otherwise require the mediator to produce records, notes or work product, or to testify in any future proceedings as to information disclosed or representations made in the course of mediation, except to the extent disclosure is required by law.

D.3.7 Unless otherwise directed by Owner, Contractor shall proceed with the Work while any Claim, or mediation or litigation arising from a Claim, is pending. Regardless of the review period or the final decision of the Owner, the Contractor shall continue to diligently pursue the Work as identified in the Contract Documents. In no case is the Contractor justified or allowed to cease or Delay Work, in whole or in part, without a written stop work order from the Owner.

SECTION E
PAYMENTS

E.1 SCHEDULE OF VALUES

The Contractor shall submit, at least ten (10) Days prior to submission of its first application for progress payment, a schedule of values ("Schedule of Values") for the contracted Work. This schedule shall provide a breakdown of values for the contracted Work and will be the basis for progress payments. The breakdown shall demonstrate reasonable, identifiable, and measurable components of the Work.
Unless objected to by the Owner, this schedule shall be used as the basis for reviewing Contractor's applications for payment. If objected to by Owner, Contractor shall revise the schedule of values and resubmit the same for approval of Owner.

E.2 APPLICATIONS FOR PAYMENT

E.2.1 Owner shall make progress payments on the Contract monthly as Work progresses, in accordance with the requirements of this Section E.2. Applications for payment shall be based upon estimates of Work completed and the Schedule of Values. As a condition precedent to Owner's obligation to pay, all applications for payment shall be approved by the Owner. A progress payment shall not be considered acceptance or approval of any Work or waiver of any defects therein. Owner shall pay to Contractor interest for overdue invoices at the rate of two- thirds of one percent per month on the progress payment, not including retainage, due the Contractor. Overdue invoices will be those that have not been paid within forty-five (45) days from the latest of:

(a) The date of the receipt of the accurate invoice;
(b) The date Owner receives the correct application for payment if no invoice is received;
(c) The date all goods and services have been received; or
(d) The date a Claim is made certain by agreement of the parties or by operation of law.

Notwithstanding the foregoing, in instances when an application for payment is filled out incorrectly, or when there is any defect or impropriety in any submitted application or when there is a good faith dispute, Owner shall so notify the Contractor within fifteen (15) Days stating the reason or reasons the application for payment is defective or improper or the reasons for the dispute. A defective or improper application for payment, if corrected by the Contractor within seven (7) Days of being notified by the Owner, shall not cause a payment to be made later than specified in this section unless interest is also paid. Payment of interest will be postponed when payment on the principal is delayed because of disagreement between the Owner and the Contractor.

Owner reserves the right, instead of requiring the Contractor to correct or resubmit a defective or improper application for payment, to reject the defective or improper portion of the application for payment and pay the remainder of the application for such amounts which are correct and proper.

Owner, upon written notice to the Contractor, may elect to make payments to the Contractor only by means of Electronic Funds Transfers (EFT) through Automated Clearing House (ACH) payments. If Owner makes this election, the Contractor shall arrange for receipt of the EFT/ACH payments.

E.2.2 .2 Contractor shall submit to the Owner an application for each payment and, if required, receipts or other vouchers showing payments for materials and labor including payments to Subcontractors. Contractor shall include in its application for payment a schedule of the percentages of the various parts of the Work completed, based on the Schedule of Values which shall aggregate to the payment application total, and shall include, on the face of each copy thereof, a certificate in substantially the following form:

"I, the undersigned, hereby certify that the above bill is true and correct, and the payment therefore, has not been received.

Signed: _____
Dated: _____"

E.2.3 Generally, applications for payment will be accepted only for materials that have been installed. Under special conditions, applications for payment for stored materials will be accepted at Owner's sole discretion. Such a payment, if made, will be subject to the following conditions:

(a) The request for stored material shall be submitted at least thirty (30) Days in advance of the application for payment on which it appears. Applications for payment shall be entertained for major equipment, components or expenditures only.

(b) The Contractor shall submit applications for payment showing the quantity and cost of the material stored.

(c) The material shall be stored in a bonded warehouse and Owner shall be granted the right to access the material for the purpose of removal or inspection at any time during the Contract Period.

(d) The Contractor shall name the Owner as co-insured on the insurance policy covering the full value of the property while in the care and custody of the Contractor until it is installed. A certificate noting this coverage shall be issued to the Owner.

(e) Payments shall be made for materials and equipment only. The submitted amount in the application for payment shall be reduced by the cost of transportation from the storage site to the project site and for the cost of an inspector to verify delivery and condition of the goods at the storage site. The cost of storage and inspection shall be borne solely by the Contractor.

(f) Within sixty (60) Days of the application for payment, the Contractor shall submit evidence of payment covering the material and/or equipment stored and of payment for the storage site.

(g) Payment for stored materials and/or equipment shall in no way indicate acceptance of the materials and/or equipment or waive any rights under this Contract for the rejection of the Work or materials and/or equipment not in conformance with the Contract Documents.

(h) All required documentation shall be submitted with the respective application for payment.

E.2.4 The Owner reserves the right to withhold all or part of a payment, or may nullify in whole or part any payment previously made, to such extent as may be necessary in the Owner's opinion to protect the Owner from loss because of:

(a) Work that is defective and not remedied, or that has been demonstrated or identified as failing to conform with Applicable Laws or the Contract Documents,

(b) third party claims filed or evidence reasonably indicating that such claims will likely be filed unless security acceptable to the Owner is provided by the Contractor;

(c) failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment (in which case Owner may issue checks made payable jointly to Contractor and such unpaid persons under this provision, or directly to Subcontractors and suppliers at any level under Section C.3.2.);

(d) reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Price;

(e)) damage to the Work, Owner or another contractor;

(f) reasonable evidence that the Work will not be completed within the Contract Time required by the Contract, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;

(g) failure to carry out the Work in accordance with the Contract Documents; or

(h) assessment of liquidated damages, when withholding is made for offset purposes.

E.2.5 Subject to the provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

(a) Take that portion of the Contract Price properly allocable to completed Work as determined by multiplying the percentage completion of each portion of the Work by the share of the total Contract Price allocated to that portion of the Work in the Schedule of Values, less retainage as provided in Section E.5. Pending final determination of cost to the Owner of changes in the Work, no amounts for changes in the Work can be included in applications for payment until the Contract Price has been adjusted by an Amendment or Change Order;

(b) Add that portion of the Contract Price properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction (or, if approved in advance by the Owner pursuant to Section E.2.3, suitably stored off the site at a location agreed upon in writing), less retainage as provided in Section E.5;

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

(d) Subtract any amounts for which the Owner has withheld or nullified payment as provided in the Contract Documents.

E.2.6 Contractor's applications for payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay to a Subcontractor or material supplier.

E.2.7 The Contractor warrants to Owner that title to all Work covered by an application for payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an application for payment all Work for which payments are received from the Owner shall be free and clear of liens, claims, security interests or encumbrances in favor of the Contractor, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided financing, labor, materials and equipment relating to the Work.

E.2.8 If Contractor disputes any determination by Owner with regard to any application for payment, Contractor nevertheless shall continue to expeditiously perform the Work. No payment made hereunder shall be or be construed to be final acceptance or approval of that portion of the Work to which such partial payment relates or shall relieve Contractor of any of its obligations hereunder.

E.2.9 Contractor shall submit its initial MWESB Report within ten (10) Days of Contractor's execution of the Contract, or if there will be a Guaranteed Maximum Price (GMP) Amendment, then within ten (10) Days of Contractor's execution of the GMP Amendment. Contractor shall submit annual MWESB Reports on June 30 of each year the Contract is active. Contracts (or GMP Amendments) first executed by Contractor within ninety (90) Days before June 30 of the year of execution by Contractor may at the discretion of Owner be exempt from submitting the annual MWESB Report otherwise due on that June 30. The final MWESB Report shall be filed with the application for final payment. Timely receipt of MWESB Reports by Owner shall be a condition precedent to Owner's obligation to pay any progress payments or final payment otherwise due.

E.3 PAYROLL CERTIFICATION REQUIREMENT

Owner's receipt of payroll certification pursuant to Section C.2 of this Contract shall be a condition precedent to Owner's obligation to pay any progress payments or final payment otherwise due.

E.4 DUAL PAYMENT SOURCES

Contractor shall not be compensated for Work performed under this Contract from any state agency other than the agency that is a party to this Contract.

E.5 RETAINAGE

E.5.1 Retainage shall be withheld and released in accordance with the requirements set forth in OSU Standard580-063-0045.

E.5.1.1 Owner may reserve as retainage from any progress payment an amount not to exceed five percent of the payment. As Work progresses, Owner may reduce the amount of retainage on or may eliminate retainage on any remaining monthly Contract payments after 50 percent of the Work under the Contract is completed if, in the Owner's discretion, such Work is progressing satisfactorily. Elimination or reduction of retainage shall be allowed at Owner's sole discretion and only upon written application by the Contractor, which application shall include written approval of Contractor's surety; except that when the Work is 97-1/2 percent completed the Owner may, at its discretion and without application by the Contractor, reduce the retained amount to 100 percent of the value of the Work remaining to be done. Upon receipt of written application by the Contractor, Owner shall respond in writing within a reasonable time.

E.5.1.2 Contractor may request in writing:

(a) to be paid amounts which would otherwise have been retained from progress payments where Contractor has deposited acceptable bonds and securities of equal value with Owner or in a custodial account or other mutually- agreed account satisfactory to Owner, with an approved bank or trust company to be held in lieu of the cash retainage for the benefit of Owner;

(b) for construction projects over $1,000,000, that retainage be deposited in an interest bearing account, established through the State Treasurer for state agencies, in a bank, savings bank, trust company or savings association for the benefit of Owner, with earnings from such account accruing to the Contractor; or

(c) that the Owner allow Contractor to deposit a surety bond for the benefit of Owner, in a form acceptable to Owner, in lieu of all or a portion of funds retained, or to be retained. Such bond and any proceeds therefrom shall be made subject to all claims in the manner and priority as set forth for retainage.

When the Owner has accepted the Contractor's election of option (a) or (b), Owner may recover from Contractor any additional costs incurred through such election by reducing Contractor's final payment. Where the Owner has agreed to Contractor's request for option (c), Contractor shall accept like bonds from Subcontractors and suppliers on the project from which Contractor has required retainages.

E. 5.1.3 The retainage held by Owner shall be included in and paid to the Contractor as part of the Final Payment of the Contract Price. The Owner shall pay to Contractor interest at the rate of two- thirds of one percent per month on the final payment due Contractor, interest to commence forty-five (45) Days after the date which Owner receives Contractor's final approved application

for payment and Work under the Contract has been completed and accepted and to run until the date when final payment is tendered to Contractor. The Contractor shall notify Owner in writing when the Contractor considers the Work complete and deliver to Owner its final application for payment and Owner shall, within fifteen (15) Days after receiving the written notice and the application for payment, either accept the Work or notify the Contractor of Work yet to be performed on the Contract. If Owner does not within the time allowed notify the Contractor of Work yet to be performed to fulfill contractual obligations, the interest provided by this subsection shall commence to run forty-five (45) Days after the end of the 15- Day period.

E.5.1.4 Owner will reduce the amount of the retainage if the Contractor notifies the controller of the Owner that the Contractor has deposited in an escrow account with a bank or trust company, in a manner authorized by the Owner, bonds and securities of equal value of a kind approved by the Owner and such bonds and securities have in fact been deposited.

E.5.1.5 Contractor agrees that if Contractor elects to reserve a retainage from any progress payment due to any Subcontractor or supplier, such retainage shall not exceed five percent of the payment, and such retainage withheld from Subcontractors and suppliers shall be subject to the same terms and conditions stated in Subsection E.5 as apply to Owner's retainage from any progress payment due to Contractor.

E.6 FINAL PAYMENT

E.6.1 Upon completion of all the Work under this Contract, the Contractor shall notify the Owner, in writing, that Contractor has completed Contractor's obligations under the Contract and shall prepare its application requesting final payment. Upon receipt o f such notice and application for payment, the Owner will inspect the Work, and, if acceptable, submit to the Owner a recommendation as to acceptance of the completed Work and the final estimate of the amount due the Contractor. If the Work is not acceptable, Owner will notify Contractor within fifteen (15) Days of Contractor's request for Final Payment. Upon approval of this final application for payment by the Owner and compliance by the Contractor with provisions in Section K, and Contractor's satisfaction of other provisions of the Contract Documents as may be applicable, the Owner shall pay to the Contractor all monies due under the provisions of these Contract Documents.

E.6.2 Neither Final Payment nor any remaining retained percentage shall become due until the Contractor submits to the Owner (1) a certificate evidencing that insurance required by the Contract Documents to remain in force after Final Payment is currently in effect and will not be canceled or allowed to expire until at least thirty (30) Days' prior written notice has been given to the Owner, (2) a written statement that the Contractor knows of no substantial reason that the insurance will not be renewable to cover the period required by the Contract Documents, (3) consent of surety, if any, to Final Payment and (4), if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien. If such lien remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging such lien, including all costs and reasonable attorneys' fees.

E.6.3 Acceptance of Final Payment by the Contractor, a Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final application for payment.

E.6.4 Contractor agrees to submit its final payment application within ninety (90) Days after Substantial Completion, unless written extension is granted by Owner. Contractor shall not delay Final Payment application for any reason, including without limitation nonpayment of Subcontractors, suppliers, manufacturers or others not a party to this Contract, or lack of resolution of a dispute with Owner or any other person of matters arising out of or relating to the Contract. If Contractor fails to submit its Final Payment application within ninety (90) Days after Substantial Completion, and Contractor has not obtained written extension by Owner, all requests or Claims for additional costs or an extension of Contract Time shall be waived.

SECTION F
JOB SITE CONDITIONS

F.1 USE OF PREMISES

Contractor shall confine equipment, storage of materials and operation of Work to the limits indicated by Contract Documents, Applicable Laws, permits or directions of the Owner. Contractor shall follow the Owner's instructions regarding use of premises, if any.

F.2 PROTECTION OF WORKERS, PROPERTY AND THE PUBLIC

F.2.1 Contractor shall maintain continuous and adequate protection of all of the Work from damage and shall protect the Owner, workers and property from injury or loss arising in connection with this Contract. Contractor shall remedy acceptably to the Owner any damage, injury, or loss, except such as may be directly due to errors in the Contract Documents or caused by authorized representatives or personnel of the Owner. Contractor shall adequately protect adjacent property as provided by law and the Contract Documents.

F.2.2 Contractor shall take all necessary precautions for the safety of all personnel on the job site or otherwise engaged in the undertaking of the Work and shall comply with the Contract Documents, best practices and all applicable provisions of federal, state and municipal safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the Work is being performed. Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all necessary safeguards f o r protection of workers and the public against any hazards created by construction. Contractor shall designate a responsible employee or associate on the Work site, whose duty shall be the prevention of accidents. The name and position of the person designated shall be reported to the Owner. The Owner has no responsibility for Work site safety. Work site safety shall be the responsibility of the Contractor.

F.2.3 Contractor shall not enter upon private property without first obtaining permission from the property owner or its duly authorized representative. Contractor shall be responsible for the preservation of all public and private property along and adjacent to the Work contemplated under the Contract and shall use every precaution necessary to prevent damage thereto. In the event the Contractor damages any property, the Contractor shall at once notify the property owner and make, or arrange to make, full restitution. Contractor shall, immediately and in writing, report to the Owner, all pertinent facts relating to such property damage and the ultimate disposition of the claim for damage.

F.2.4 Contractor shall be responsible for protection of adjacent work areas including impacts brought about by activities, equipment, labor, utilities, vehicles and materials on the site.

F.2.5 Contractor shall at all times direct its activities in such a manner as to minimize adverse effects on the environment. Handling of all materials shall be conducted so no release will occur that may pollute or become hazardous.

F.2.6 In an emergency affecting the safety of life or limb or of the Work or of adjoining property, the Contractor, without special instruction or authorization from the Owner, shall act reasonably to prevent threatened loss or injury, and shall so act, without appeal, if instructed by the Owner. Any compensation claimed by the Contractor on account of emergency work shall be determined in accordance with section D.

F.3 CUTTING AND PATCHING

F.3.1 Contractor shall be responsible for coordinating all cutting, fitting, or patching of the Work to make its several parts come together properly and fit to receive or be received by work of other contractors or Subcontractors shown upon, or reasonably implied by, the Contract Documents.

F.3.2 Contractor shall be responsible for restoring all cut, fitted, or patched surfaces to an original condition; provided, however, that if a different condition is specified in the Contract Documents, then Contractor shall be responsible for restoring such surfaces to the condition specified in the Contract Documents.

F.4 CLEANING UP

From time to time as may be prudent or ordered by the Owner and, in any event, immediately after completion of the Work, the Contractor shall, at its own expense, clean up and remove all refuse and unused materials of any kind resulting from the Work. If Contractor fails to do so within twenty-four hours after notification by the Owner the work may be done by others and the cost charged to the Contractor and deducted from payment due the Contractor.

F.5 ENVIRONMENTAL CONTAMINATION

F.5.1. Contractor shall be held responsible for and shall indemnify, defend (with counsel of Owner's choice),and hold harmless Owner from and against any costs, expenses, damages, claims, and causes of action, (including attorneys' fees), or any of them, resulting from all spills, releases, discharges, leaks and disposal of environmental pollution, including storage, transportation, and handling during the performance of the Work or Contractor's obligations under the Contract which occur as a result of, or are contributed by, the negligence or actions of Contractor or its personnel, agents, or Subcontractors or any failure to perform in accordance with the Contract Documents (except to the extent otherwise void under ORS 30.140). Nothing in this section F.5.1 shall limit Contractor's responsibility for obtaining insurance coverages required under Section G.3 of this Contract, and Contractor shall take no action that would void or impair such coverages.

F.5.1.1 Contractor agrees to promptly dispose of such spills, releases, discharge or leaks to the satisfaction of Owner and regulatory agencies having jurisdiction in a manner that complies with Applicable Laws. Cleanup shall be at no cost to the Owner and shall be performed by properly qualified and, if applicable, licensed personnel.

F.5.1.2 Contractor shall obtain the Owner's written consent prior to bringing onto the Work site any (i) environmental pollutants or
(ii) hazardous substances or materials, as the same or reasonably similar terms are used in any Applicable Laws. Notwithstanding such written consent from the Owner, the Contractor, at all times, shall:

(a) properly handle, use and dispose of all environmental pollutants and hazardous substances or materials brought onto the Work site, in accordance with all Applicable Laws;

(b) be responsible for any and all spills, releases, discharges, or leaks of (or from) environmental pollutants or hazardous substances or materials which Contractor has brought onto the Work site; and

(c) promptly clean up and remediate, without cost to the Owner, such spills, releases, discharges, or leaks to the Owner's satisfaction and in compliance with all Applicable Laws.

F.5.2 Contractor shall report all reportable quantity releases, as such releases are defined in Applicable Laws, including but not limited to 40 CFR Part 302, Table 302.4 and in OAR 340-142- 0050, to applicable federal, state, and local regulatory and emergency response agencies. Upon discovery, regardless of quantity, Contractor must telephonically report all releases to the Owner. A written follow-up report shall be submitted to Owner within 48 hours of the telephonic report. Such written report shall contain, as a minimum:

(a) Description of items released (identity, quantity, manifest numbers, and any and all other documentation required by law.)

(b) Whether amount of items released is EPA/DEQ reportable, and, if so, when reported.

(c) Exact time and location of release, including a description of the area involved.

(d) Containment procedures initiated.

(e) Summary of communications about the release between Contractor and members of the press or Stat, local or federal officials other than

Owner.

(f) Description of cleanup procedures employed or to be employed at the site, including disposal location of spill residue.

(g) Personal injuries, if any, resulting from, or aggravated by, the release.

F.6 ENVIRONMENTAL CLEAN-UP

F.6.1 Unless disposition of environmental pollution is specifically a part of this Contract, or was caused by the Contractor (reference F.5 Environmental Contamination), Contractor shall immediately notify Owner of any hazardous substance(s) which Contractor discovers or encounters during performance of the Work required by this Contract. "Hazardous substance(s)" means any hazardous, toxic and radioactive materials and those substances defined as "hazardous substances," "hazardous materials," "hazardous wastes," "toxic substances," or other similar designations in any federal, state, or local law, regulation, or ordinance, including without limitation asbestos, polychlorinated biphenyl (PCB), or petroleum, and any substances, materials or wastes regulated by 40 CFR, Part 261 and defined as hazardous in 40 CFR S 261.3. In addition to notifying Owner of any hazardous substance(s) discovered or encountered, Contractor shall immediately cease working in any particular area of the project where a hazardous substance(s) has been discovered or encountered if continued work in such area would present a risk or danger to the health or well-being of Contractor's or any Subcontractor's work force, property or the environment.

F.6.2 Upon being notified by Contractor of the presence of hazardous substance(s) on the project site, Owner shall arrange for the proper disposition of such hazardous substance(s).

F.7 FORCE MAJEURE

A party to this Contract shall not be held responsible for delay or default due to Force Majeure acts, events or occurrences unless they could have been avoided by the exercise of reasonable care, prudence, foresight, and diligence by that party. The Owner may terminate this Contract upon written notice after determining that delay or default caused by Force Majeure acts, events or occurrences will reasonably prevent successful performance of the Contract.

SECTION G INDEMNITY, BONDING, AND INSURANCE

G.1 RESPONSIBILITY FOR DAMAGES / INDEMNITY

G.1.1 Contractor shall be responsible for all damage to property, injury to persons, and loss, expense, inconvenience, and delay that may be caused by, or result from, the carrying out of the Work to be done under this Contract, or from any act, omission or neglect of the Contractor, its Subcontractors, sub-subcontractors of any tier, suppliers, employees, guests, visitors, invitees and agents.

G.1.2 To the fullest extent permitted by law, Contractor shall indemnify, defend (with counsel approved by Owner) and hold harmless the Owner, Architect/Engineer, Architect/Engineer's consultants, and their respective officers, directors, agents, employees, partners, members, stockholders and affiliated companies (collectively "Indemnitees") from and against all liabilities, damages, losses, claims, expenses (including reasonable attorney fees), demands and actions of any nature whatsoever which arise out of, result from or are related to, (a) any damage, injury, loss, expense, inconvenience or delay described in this Section G.1., (b) any accident or occurrence which happens or is alleged to have happened in or about the project site or any place where the Work is being performed, or in the vicinity of either, at any time prior to the time the Work is fully completed in all respects, (c) any failure of the Contractor or its Subcontractors, sub-subcontractors of any tier, suppliers, employees, or consultants to observe or perform any duty or obligation under the Contract Documents which is to be observed or performed by the Contractor, or any breach of any agreement, representation or warranty of the Contractor contained in the Contract Documents or in any subcontract, (d) the negligent acts or omissions of the Contractor, a Subcontractor, sub-subcontractor of any tier, a supplier, a consultant, or anyone directly or indirectly employed by them or any one of them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss or expense is caused in part by a party indemnified hereunder (except to the extent otherwise void under ORS 30.140), and (e) any lien filed upon the project or bond claim in connection with the Work. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity which would otherwise exist as to a party or person described in this Section G.1.2.

G.1.3 In claims against any person or entity indemnified under Section G.1.2 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under Section G.1.2 shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts or other employee benefit acts.

G.2 PERFORMANCE AND PAYMENT SECURITY; PUBLIC WORKS BOND

G.2.1 When the Contract Price is $100,000 or more (or $50,000 or more in the case of Contracts for highways, bridges and other transportation projects), the Contractor shall furnish and maintain in effect at all times during the Contract Period a performance bond in a sum equal to the Contract Price and a separate payment bond also in a sum equal to the Contract Price. Contractor shall furnish such bonds even if the Contract Price is less than the above thresholds if otherwise required by the Contract Documents.

G.2.2 Bond forms furnished by the Owner and notarized by awarded Contractor's surety company authorized to do business in Oregon are the only acceptable forms of performance and payment security, unless otherwise specified in the Contract Documents.

G.2.3 Before execution of the Contract the Contractor shall file with the Construction Contractors Board, and maintain in full force and effect, the separate public works bond required by Oregon Laws 2015, Chapter 279C, and OAR 839-025-0015, unless otherwise exempt under those provisions. The Contractor shall also include in every subcontract a provision requiring the Subcontractor to have a public works bond filed with the

Construction Contractors Board before starting Work, unless otherwise exempt, and shall verify that the Subcontractor has filed a public works bond before permitting any Subcontractor to start Work.

G.3 INSURANCE

G.3.1 Primary Coverage: Insurance carried by Contractor and Subcontractors under this Contract shall be the primary coverage. The coverages indicated are minimums unless otherwise specified in the Contract Documents.

G.3.2 Workers' Compensation: All employers, including Contractor, that employ subject workers who work under this Contract in the State of Oregon shall comply with ORS 656.017 and provide the required Workers' Compensation coverage, unless such employers are exempt under ORS 656.126. This shall include Employer's Liability Insurance with coverage limits of not less than the minimum amount required by statute for each accident. Contractors who perform the Work without the assistance or labor of any employee need not obtain such coverage if the Contractor certifies so in writing. Contractor shall ensure that each of its Subcontractors complies with these requirements. The Contractor shall require proof of such Workers' Compensation coverage by receiving and keeping on file a certificate of insurance from each Subcontractor or anyone else directly employed by either the Contractor or its Subcontractors.

G.3.3 Builder's Risk Insurance:

G.3.3.1 Builder's Risk: During the term of this Contract, for new construction the Contractor shall obtain and keep in effect Builder's Risk insurance on an all risk forms, including earthquake and flood, for an amount equal to the full amount of the Contract, plus any changes in values due to modifications, Change Orders and loss of materials added. Such Builder's Risk shall include, in addition to earthquake and flood, theft, vandalism, mischief, collapse, transit, debris removal, and architect's fees "soft costs" associated with delay of project due to insured peril. Any deductible shall not exceed $50,000 for each loss, except the earthquake and flood deductible which shall not exceed 2 percent of each loss or $50,000, whichever is greater. The deductible shall be paid by Contractor if Contractor or its Subcontractors are negligent. The policy will include as loss payees Owner, the Contractor and its Subcontractors as their interests may appear.

G.3.3.2 Builder's Risk Installation Floater: For Work other than new construction, Contractor shall obtain and keep in effect during the term of this Contract, a Builder's Risk Installation Floater for coverage of the Contractor's labor, materials and equipment to be used for completion of the Work performed under this Contract. The minimum amount of coverage to be carried shall be equal to the full amount of the Contract. The policy will include as loss payees Owner, the Contractor and its Subcontractors as their interests may appear. Owner may waive this requirement at their sole and absolute discretion.

G.3.3.3 Such insurance shall be maintained until Owner has occupied the facility.

G.3.3.4 Loss insured under the Builder's Risk insurance shall be adjusted by the Owner and made payable to the Owner as loss payee. The Contractor shall pay Subcontractors their just shares of insurance proceeds received by the Contractor, and

by appropriate agreements, written where legally required for validity, shall require Subcontractors to make payments to their sub-subcontractors of any tier in similar manner. The Owner shall have power to adjust and settle a loss with insurers.

G.3.4 General Liability Insurance:

G.3.4.1 Commercial General Liability: Upon issuance of a Contract, Contractor shall obtain, and keep in effect at Contractor's expense for the term of the Contract, Commercial General Liability Insurance covering bodily injury and property damage in the amount of $1,000,000 per claim and $2,000,000 per occurrence in a form satisfactory to Owner. This insurance shall include personal injury liability, products and completed operations, no subcontractors' limitations, and blanket contractual liability coverage for the indemnities provided under this Contract (to the extent contractual liability coverage for the indemnity is available in the marketplace), and shall be issued on an occurrence basis.

G.3.4.2 Automobile Liability: Contractor shall obtain, at Contractor's expense, and keep in effect during the term of this Contract, Automobile Liability Insurance covering owned, and/or hired vehicles, as applicable. The coverage may be written in combination with the Commercial General Liability Insurance. Contractor shall provide proof of insurance of not less than $1,000,000 per claim and $2,000,000 per occurrence. Contractor and its Subcontractors shall be responsible for ensuring that all non-owned vehicles maintain adequate Automobile Liability insurance while on site.

G.3.4.3 Owner may adjust the insurance amounts required in Section
G.3.4.1 and G.3.4.2 based upon institution specific risk assessments through the issuance of Supplemental General Conditions and a Contract.

G.3.4.4 "Tail" Coverage: If any of the required liability insurance is arranged on a "claims made" basis, "tail" coverage will be required at the completion of this Contract for a duration of 36 months or the maximum time period available in the marketplace if less than 36 months. Contractor shall furnish certification of "tail" coverage as described or continuous "claims made" liability coverage for 36 months following Final Completion. Continuous "claims made" coverage will be acceptable in lieu of "tail" coverage, provided its retroactive date is on or before the effective date of this Contract. Owner's receipt of the policy endorsement evidencing such coverage shall be a condition precedent to Owner's obligation to make final payment and to Owner's final acceptance of Work or services and related warranty (if any).

G.3.4.5: Umbrella Liability: Contractor shall obtain, at Contractor's expense, and keep in effect during the term of this Contract, Umbrella liability Insurance over and above the general liability, automobile liability and workers' compensation coverage if required by Owner in specified limits at time of requirement.

G.3.4.6 Pollution Liability (if required by Owner through issuance of Supplemental General Conditions): Contractor shall obtain, at Contractor's expense, and

keep in effect during the term of this Contract, Pollution liability Insurance in minimum amounts of $3,000,000 naming Owner as "additional insured," as noted in the "additional insured section below.

G.3.5 Additional Insured: The general liability insurance coverage, professional liability, umbrella, and pollution liability if required, shall include the Owner as additional insureds but only with respect to the Contractor's activities to be performed under this Contract, and shall include completed operations coverage.

If Contractor cannot obtain an insurer to name the Owner as additional insureds, Contractor shall obtain at Contractor's expense, and keep in effect during the term of this Contract, Owners and Contractors Protective Liability Insurance, naming the Owner as additional insureds with not less than a $2,000,000 limit per occurrence. This policy must be kept in effect for at least 36 months following Final Completion. As evidence of coverage, Contractor shall furnish the actual policy to Owner prior to execution of the Contract.

G.3.6 Notice of Cancellation or Change: If the Contractor receives a non-renewal or cancellation notice from an insurance carrier affording coverage required herein, or receives notice that coverage no longer complies with the insurance requirements herein, Contractor agrees to notify Owner by fax within five (5) business days with a copy of the non-renewal or cancellation notice, or written specifics as to which coverage is no longer in compliance. When notified by Owner, the Contractor agrees to stop Work pursuant to this Contract, unless all required insurance remain in effect. Any failure to comply with the reporting provisions of this insurance, except for the potential exhaustion of aggregate limits, shall not affect the coverages provided to the Owner and its institutions, divisions, officers, and employees.

Owner shall have the right, but not the obligation, of prohibiting Contractor from entering the Work site until a new certificate(s) of insurance is provided to Owner evidencing the replacement coverage. The Contractor agrees Owner reserves the right to withhold payment to Contract until evidence of reinstated or replacement coverage is provided to Owner.

G.3.7 Certificate(s) of Insurance: As evidence of the insurance coverage required by this Contract, the Contractor shall furnish certificate(s) of insurance to the Owner prior to execution of the Contract. The certificate(s) will specify all of the parties who are additional insureds or loss payees for this contract. Insurance coverage required under this Contract shall be obtained from insurance companies or entities acceptable to the Owner and that are eligible to provide such insurance under Oregon law. Eligible insurers include admitted insurers that have been issued a certificate of authority from the Oregon Department of Consumer and Business Services authorizing them to conduct an insurance business and issue policies of insurance in the state of Oregon, and certain non-admitted surplus lines insurers that satisfy the requirements of applicable Oregon law and which are subject to approval by the Owner. The Contractor shall be financially responsible for all deductibles, self-insured retentions and/or self-insurance included hereunder. Any deductible, self-insured retention and/or self-insurance in excess of $50,000 shall be subject to approval by the Owner in writing and shall be a condition precedent to the effectiveness of any Contract. The Owner has the right to require the Contractor at any time during the performance of the Work to furnish to Owner copies of the Contractor's actual policies.

SECTION H
SCHEDULE OF WORK

H.1 CONTRACT PERIOD

H.1.1 Time is of the essence. The Contractor shall at all times carry on the Work diligently, without delay and punctually fulfill all requirements herein. If required by the Contract Documents, Contractor shall commence Work on the site within fifteen (15) Days of Notice to Proceed, unless directed otherwise.

H.1.2 Unless specifically extended by an Amendment or Change Order, all Work shall be complete by the date contained in the Contract Documents. The Owner shall have the right to accelerate the completion date of the Work, which may require the use of overtime. Such accelerated Work schedule shall be an acceleration in performance of Work under Section D.1.2 (f) and shall be subject to the provisions of Section D.1.

H.1.3 The Owner shall not waive any rights under the Contract by permitting the Contractor to continue or complete in whole or in part the Work after the date described in Section H.1.2 above.

H.2 SCHEDULE

H.2.1 Contractor shall provide, by or before the pre-construction conference, the initial as-planned Construction Schedule for review and acceptance by the Owner. The submitted Construction Schedule must illustrate Work by project components, labor trades, and long lead items broken down by building and/or floor where applicable. If Owner shall so elect, Contractor shall provide the Construction Schedule in CPM format showing the graphical network of planned activities, including i) a reasonably detailed list of all activities required to complete the Work; ii) the time and duration that each activity will take to completion; and iii) the dependencies between the activities. Construction Schedules lacking adequate detail, or unreasonably detailed, will be rejected. The Construction Schedule shall include the following: Notice to Proceed or the date the Work commences, if no Notice to Proceed is issued by Owner, Substantial Completion, and Final Completion. Construction Schedules shall be updated monthly, unless otherwise required by the Contract Documents, and submitted with the monthly application for payment. Acceptance of the Construction Schedule by the Owner does not constitute agreement by the Owner as to the Contractor's sequencing, means, methods, or durations. Any positive difference between the Contractor's scheduled completion and the Contract completion date is float owned by the Owner. Owner reserves the right to negotiate the float if it is deemed to be in Owner's best interest to do so. In no case shall the Contractor make a claim for delays if the Work is completed within the Contract Time but after Contractor's scheduled completion.

H.3 PARTIAL OCCUPANCY OR USE

H.3.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage, provided such occupancy or use is consented to by public authorities having jurisdiction over the Work. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have reasonably accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, insurance or self-insurance, maintenance, heat, utilities, and damage to the Work, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents with respect to such portion of the Work. Approval by the Contractor to partial occupancy or use shall not be unreasonably withheld. Immediately prior to such partial occupancy or use, the Owner and Contractor shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work. Partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

SECTION I
CORRECTION OF WORK

I.1 CORRECTION OF WORK BEFORE FINAL PAYMENT

The Contractor warrants to the Owner that materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work will be free from defects, and that the Work will conform to the requirements of the Contract Documents. Work failing to conform to these requirements shall be deemed defective. Contractor shall promptly remove from the premises and replace all defective materials and equipment as determined by the Owner, whether incorporated in the Work or not. Removal and replacement shall be without loss or expense to the Owner, and Contractor shall bear the cost of repairing all Work destroyed or damaged by such removal or replacement. Contractor shall be allowed a period of no longer than thirty (30) Days after Substantial Completion for completion of defective (Punch List) work. At the end of the thirty-day period, or earlier if requested by the Contractor, Owner shall arrange for inspection of the Work by the Architect/Engineer. Should the work not be complete, and all corrections made, the costs for all subsequent re-inspections shall be borne by the Contractor. If Contractor fails to complete the Punch List work within the thirty (30) Day period, Owner may perform such work and Contractor shall reimburse Owner all costs of the same within ten (10) Days after demand without affecting Contractor's obligations.

I.2 WARRANTY WORK

I.2.1 Neither the final certificate of payment nor any provision of the Contract Documents shall relieve the Contractor from responsibility for defective Work and, unless a longer period is specified, Contractor shall correct all defects that appear in the Work within a period of one year from the date of issuance of the written notice of Substantial Completion by the Owner except for latent defects which will be remedied by the Contractor at any time they become apparent. The Owner shall give Contractor notice of defects with reasonable promptness. The Contractor shall perform the warranty Work by correcting defects within twenty-four (24) hours of notification by Owner, unless otherwise specified in the Contract Documents. Should the Contractor fail to respond within the specified response time, the Owner may, at its option, complete the necessary repairs using another contractor or its own forces. If Owner completes the repairs using Owner's own forces, Contractor shall pay Owner at the rate of one and one-half (1½) times the standard hourly rate of Owner's forces, plus related overhead and any direct non-salary costs. If Owner completes the repairs using another contractor, Contractor shall pay Owner the amount of Owner's direct costs billed by the other contractor for the work, plus the direct salary costs and related overhead and direct non-salary expenses of Owner's forces who are required to monitor that contractor's work. Work performed by Owner using Owner's own forces or those of another contractor shall not affect the Contractor's contractual duties under these provisions, including warranty provisions. In the event of warranty work consisting of emergency repairs, Owner may perform such work and Contractor shall reimburse Owner all costs of the same within ten (10) Days after demand, without affecting Contractor's obligations.

I.2.2 Nothing in this Section I.2 provision shall negate guarantees or warranties for periods longer than one year including without limitation such guarantees or warranties required by other sections of the Contract Documents for specific installations, materials, processes, equipment or fixtures.

I.2.3 In addition to Contractor's warranty, manufacturer's warranties shall pass to the Owner and shall not take effect until such portion of the Work covered by the applicable warranty has been accepted in writing by the Owner.

I.2.4 The one-year period for correction of Work shall be extended with respect to portions of Work performed after Substantial Completion by the period of time between Substantial Completion and the actual performance of the Work, and shall be extended by corrective Work performed by the Contractor pursuant to this Section, as to the Work corrected. The Contractor shall remove from the site portions of the Work which are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

I.2.5 Nothing contained in this Section I.2 shall be construed to establish a period of limitation with respect to other obligations which the Contractor might have under the Contract Documents. Establishment of the period for correction of Work as described in this Section I.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

I.2.6 If the Owner prefers to accept Work which is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Price will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

SECTION J
SUSPENSION AND/OR TERMINATION OF THE WORK

J.1 OWNER'S RIGHT TO SUSPEND THE WORK

J.1.1 The Owner has the authority to suspend portions or all of the Work due to the following causes:

(a) Failure of the Contractor to correct unsafe conditions;

(b) Failure of the Contractor to carry out any provision of the Contract;

(c) Failure of the Contractor to carry out orders;

(d) Conditions, in the opinion of the Owner, which are unsuitable for performing the Work;

(e) Time required to investigate differing site conditions;

(f) Any reason considered to be in the public interest.

J.1.2 The Owner shall notify Contractor and the Contractor's Surety in writing of the effective date and time of the suspension, and Owner shall notify Contractor and Contractor's surety in writing to resume Work.

J.2 CONTRACTOR'S RESPONSIBILITIES

J.2.1 During the period of the suspension, Contractor is responsible to continue maintenance at the project just as if the Work were in progress. This includes, but is not limited to, protection of completed Work, maintenance of access, protection of stored materials, temporary facilities, and clean-up.

J.2.2 When the Work is recommenced after the suspension, the Contractor shall replace or renew any Work damaged during the suspension, remove any materials or facilities used as part of temporary maintenance, and complete the project in every respect as though its prosecution had been continuous and without suspension.

J.2.3 **COMPENSATION FOR SUSPENSION**

J.2.4

J.2.1 Depending on the reason for suspension of the Work, the Contractor or the Owner may be due compensation by the other party. If the suspension was required due to acts or omissions of Contractor, the Owner may assess the Contractor actual costs of the suspension in terms of administration, remedial work by the Owner's forces or another contractor to correct the problem associated with the suspension, rent of temporary facilities, and other actual costs related to the suspension. If the suspension was caused by acts or omissions of the Owner, the Contractor may be due compensation which shall be defined using Section D, Changes in Work. If the suspension was required through no fault of the Contractor or the Owner, neither party shall owe the other for the impact.

J.4 OWNER'S RIGHT TO TERMINATE CONTRACT

J.4.1 The Owner may, without prejudice to any other right or remedy, and after giving Contractor seven (7) Days' written notice and an opportunity to cure, terminate the Contract in whole or in part under the following conditions:

(a) If Contractor should, voluntarily or involuntarily, seek protection under the United States Bankruptcy Code and Contractor as debtor-in-possession or the Trustee for the estate fails to assume the Contract within a reasonable time;

(b) If Contractor should make a general assignment for the benefit of Contractor's creditors;

(c) If a receiver should be appointed on account of Contractor's insolvency;

(d) If Contractor should repeatedly refuse or fail to supply an adequate number of skilled workers or proper materials to carry on the Work as required by the Contract Documents, or otherwise fail to perform the Work in a timely manner;

(e) If Contractor should repeatedly fail to make prompt payment to Subcontractors or for material or labor, or should disregard laws, ordinances or the instructions of the Owner; or

(f) If Contractor is otherwise in breach of any part of the Contract.

(g) If Contractor is in violation of Applicable Laws, either in the conduct of its business or in its performance of the Work.

J.4.2 At any time that any of the above occurs, Owner may exercise all rights and remedies available to Owner at law or in equity, and, in addition, Owner may take possession of the premises and of all materials and appliances and finish the Work by whatever method it may deem expedient. In such case, the Contractor shall not be entitled to receive further payment until the Work is completed. If the Owner's cost of finishing the Work exceeds the unpaid balance of the Contract Price, Contractor shall pay the difference to the Owner.

J.5 TERMINATION FOR CONVENIENCE

J.5.1 Owner may terminate the Contract in whole or in part whenever Owner determines that termination of the Contract is in the best interest of Owner or the public.

The Owner shall provide the Contractor with seven (7) Days prior written notice of a termination for Owner's or for public convenience. After such notice, the Contractor shall provide the Owner with immediate and peaceful possession of the premises and materials located on and off the premises for which the Contractor received progress payment under Section E. Compensation for Work terminated by the Owner under this provision will be according to Section E. In no circumstance shall Contractor be entitled to lost profits for Work not performed due to termination.

J.6 ACTION UPON TERMINATION

J.6.1 Upon receiving a notice of termination, and except as directed otherwise by the Owner, Contractor shall immediately cease placing further subcontracts or orders for materials, services, or facilities. In addition, Contractor shall terminate all subcontracts or orders to the extent they

relate to the Work terminated and, with the prior written approval of the Owner, settle all outstanding liabilities and termination settlement proposals arising from the termination of subcontracts and orders.

J.6.2 As directed by the Owner, Contractor shall, upon termination, transfer title and deliver to the Owner all Record Documents, information, and other property that, if the Contract had been completed, would have been required to be furnished to the Owner.

I.6.3 Upon Owner's notice of termination pursuant to either Section J.4 or J.5, if Owner shall so elect, Contractor shall assign the Owner such subcontracts and orders as Owner shall specify. In the event Owner elects to take assignment of any such subcontract or order, Contractor shall take such action and shall execute such documents as Owner shall reasonably require for the effectiveness of such assignment and Contractor shall ensure that no contractual arrangement between it and its subcontractors or suppliers of any tier or sub-tier shall prevent such assignment.

SECTION K
CONTRACT CLOSE OUT

K.1 RECORD DOCUMENTS

As a condition of final payment (refer also to section E.6), Contractor shall comply with the following: Contractor shall provide Record Documents for the entire project to Owner. Record Documents shall depict the project as constructed and shall reflect each and every change, modification, and deletion made during the construction. Record Documents are part of the Work and shall be provided prior to the Owner's issuance of final payment. Record Documents include all modifications to the Contract Documents unless otherwise directed, and accurate MWESB Reports.

K.2 OPERATION AND MAINTENANCE MANUALS

As part of the Work, Contractor shall submit two completed operation and maintenance manuals ("O & M Manuals") for review by the Owner prior to submission of any pay request for more than 75% of the Work. Owner's receipt of the O & M Manuals shall be a condition precedent to any payment thereafter due. The O & M Manuals shall contain a complete set of all Submittals, all product data as required by the specifications, training information, telephone list and contact information for all consultants, manufacturers, installer and suppliers, manufacturer's printed data, record and shop drawings, schematic diagrams of systems, appropriate equipment indices, warranties and bonds. The Owner shall review and return one O & M Manual for any modifications or adjustments required. Prior to submission of its final pay request, Contractor shall deliver two (2) complete and approved sets of O & M Manuals in paper form and one (1) complete and approved set in electronic form to the Owner and Owner's receipt of the O & M Manuals shall be a condition precedent to Owner's obligation to make final payment.

K.3 COMPLETION NOTICES

K.3.1 Contractor shall provide Owner written notice of both Substantial and Final Completion. The certificate of Substantial Completion shall state the date of Substantial Completion, the responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and the time within which the Contractor shall finish all items on the Punch List accompanying the Certificate. Both completion notices must be signed by the Contractor and the Owner to be valid. The Owner shall provide the final signature on the notices. The notices shall take effect on the date they are signed by the Owner.

K.3.2 Substantial Completion of a facility with operating systems (e.g., mechanical, electrical, HVAC) shall be that degree of completion that has provided a minimum of thirty (30) continuous Days of successful, trouble-free operation, which period shall begin after all performance and acceptance testing has been successfully demonstrated to the Owner. All equipment contained in the Work, plus all other components necessary to enable the Owner to operate the facility in the manner that was intended, shall be complete on the Substantial Completion date. The Contractor may request that a Punch List be prepared by the Owner with submission of the request for the Substantial Completion notice.

K.4 TRAINING

As part of the Work, and prior to submission of the final application for payment, the Contractor shall schedule with the Owner training sessions for all equipment and systems as required by the Contract Documents. Contractor shall schedule training sessions at least two weeks in advance of the date of training to allow Owner to provide its personnel with adequate notice. The O & M Manual shall be used as a basis for training. In addition to any off-site training required by the Contract Documents, training shall include a formal session conducted at the Work site after the equipment and/or system is completely installed and operational in its normal operating environment.

K.5 EXTRA MATERIALS

As part of the Work, Contractor shall provide spare parts, extra maintenance materials, and other materials or products in the quantities specified in the Contract Documents prior to final payment. Delivery point for extra materials shall be designated by the Owner.

K.6 ENVIRONMENTAL CLEAN-UP

As part of the Final Completion notice, or as a separate written notice submitted with or before the notice of Final Completion, the Contractor shall notify the Owner that all environmental and pollution clean-up, remediation and closure have been completed in accordance with all Applicable Laws and pursuant to the authority of all agencies having jurisdiction, and Contractor shall provide Owner with any and all documentation related to the same, including but not limited to directives, orders, letters, certificates and permits related to or arising from such environmental pollution. The notice shall reaffirm the indemnification given under Section F.5.1 above. Contractor's completion of its obligations under this Section K.6 and Owner's receipt of documents evidencing such completion shall be a condition precedent to Owner's obligation to make final payment.

K.7 CERTIFICATE OF OCCUPANCY

Owner's receipt of an unconditioned certificate of occupancy from the appropriate state and/or local building officials shall be a condition precedent to Owner's obligation to make final payment, except to the extent failure to obtain an unconditional certificate of occupancy is due to the sole fault or neglect of Owner.

K.8 OTHER CONTRACTOR RESPONSIBILITIES

The Contractor shall be responsible for returning to the

Owner all property of Owner issued to Contractor during construction such as keys, security passes, site admittance badges, and all other pertinent items. Upon notice from Owner, Contractor shall be responsible for notifying the appropriate utility companies to transfer utility charges from the Contractor to the Owner. The utility transfer date shall not be before Substantial Completion and may not be until Final Completion, if the Owner does not take beneficial use of the facility and the Contractor's forces continue with the Work.

K.9 SURVIVAL

All warranty and indemnification provisions of this Contract, and all of Contractor's other obligations under this Contract that are not fully performed by the time of Final Completion or termination, shall survive Final Completion or any termination of the Contract.

OREGON STATE UNIVERSITY

SUPPLEMENTAL GENERAL CONDITIONS

To The

PUBLIC IMPROVEMENT GENERAL CONDITIONS

Project Name Radiation Center Cooling Upgrade

The following modify the June 30, 2017 Oregon State University General Conditions ("OSU Public Improvement General Conditions") for this Contract. Where a portion of the OSU General Conditions is modified by these Supplemental General Conditions, the unaltered portions shall remain in effect.

SG-1 Section B.4 is modified as follows: Revise to read:

"Contractor shall obtain and pay for all necessary permits and licenses, except for those specifically excluded in the Supplemental General Conditions, for the construction of the Work, for temporary obstructions, enclosures, opening of streets for pipes, walls, utilities, environmental Work, etc., as required for the project. Owner shall obtain and pay for the general building permit and pay for any specialty permits required for the Work. Contractor shall be responsible for all violations of the law, in connection with the construction or caused by obstructing streets, sidewalks or otherwise. Contractor shall give all requisite notices to public authorities. The Contractor shall pay all royalties and license fees. The Contractor shall defend all suits or claims for infringement of any patent or other proprietary rights and save harmless and blameless from loss, on account thereof, Oregon State University, and its departments, divisions, members and employees.

SG-2 Section F.2.4 is modified as follows: Add the following:

"Contractor shall verify that all mechanical or electrical equipment in the construction areas that may be affected by the Work is in working order and shall notify the Owner, in writing, of any equipment not in working order prior to the start of the Work. Start of Work will be considered as acknowledgement that all equipment is in good working order. Contractor shall be required to restore equipment to its original, or better, condition upon completion of the Project."

SG-3 Section H.2.1 is replaced with the following:

"Contractor shall provide, by or before the pre-construction conference, a detailed Construction Schedule for review and acceptance by the Owner. The submitted Construction Schedule must illustrate Work by significant project components, significant labor trades, long lead items, broken down by building and/or floor where applicable. Each Construction Schedule item shall account for no greater than 5% of the monetary value of the Project or 5% of the available time. Schedules with activities of less than one day or valued at less than 1% of the Contract shall be considered too detailed and shall not be accepted. Schedules lacking adequate detail, or unreasonably detailed, shall be rejected. Included within the Construction Schedule are the following: Notice to Proceed, Substantial Completion, and Final Completion. Contractor shall provide an updated, full project schedule with each payment request. In addition, twice monthly, the Contractor shall provide an updated three-week forward-looking Construction Schedule. Acceptance of the Schedule by the Owner does not constitute agreement by the Owner as to the Contractor's sequencing, means, methods, or durations. Any positive difference between the Contractor's scheduled completion and the contract completion date is float owned by the Project. Use of the float shall be negotiated. In no case shall the Contractor make a claim for delays if the Work is completed within the Contract time but after Contractor's scheduled completion."

As indicated in the General Conditions of your contract(s) Section E.2.9, OSU requires that we gather MWESB (Minority, Women's Emerging Small Business) Contractor/Subcontractor information. This is an Oregon State University requirement and the information will be gathered annually and at time of final payment.

- **You must do this step first or the report will not let you add any information: In Row 1 Column B there is a drop down menu. You must select yearend (if the job has not been completed) or final (if the job is completed and you have submitted for retention). Once you choose yearend or final in the drop down menu there will be areas highlighted in light green and red. Those are the areas that you are required to fill out. If you did not use or planning to use any MWESB then the left side of the report (Light Green area) still needs to be filled out and the red area needs to remain blank.**

- **If your agency is an MWESB or if you are using/used an MWESB subcontractor then you need to fill out the information in the report that is highlighted in light green and red (see instructions in the next bullet). If you are not an MWESB or used a Subcontractor that is an MWESB then you need to fill out the left side of the form (Light Green areas) and leave the red area blank.**

- **In row 2 Column B there is another drop down menu, click the drop down menu and choose Fiscal Year 2015.**

- **In Row 4 Column B there is another drop down menu, click there and choose OSU.**

Oregon University System

CapCon MWESB Subcontractor Report

REPORT BEING SUBMITTED	

OVERALL PROJECT DATA

Reporting Period	2011
Campus	
General Contractor's Name	
Contract Number	
Project Name	
Contract Execution Date (Date Contract was Signed by the Owner)	
Date of Final Payment Application	
Initial Total Contract Value	
Total Contract Value billed within the fiscal year (July 1 - June 30)	
Final Total Contract Value	
Total Number of Subcontractors/Suppliers Used on Project	
Total Number of First-Tier Subcontractors/Suppliers Used on Project	
Number of First-Tier MWESB Subcontractors/Suppliers	

CALCULATED REPORTING DATA (Self Calculating - No Data Entry)

Number of MWESB Subcontractors/Suppliers	0
% MWESB Subcontractors/Suppliers	
% First-Tier MWESB Subcontractors/Suppliers	

CERTIFIED MWESB TOTALS

Value Awarded to MWESB Contractors/Suppliers	$0.00
% Value Awarded to MWESB Contractors/Suppliers	
Value - **minority-owned** MWESB subcontractors/suppliers	$0.00
% - **minority-owned** MWESB subcontractors/suppliers	
Value - **women-owned** MWESB subcontractors/suppliers	$0.00
% - **women-owned** MWESB subcontractors/suppliers	
Value - **emerging small business** MWESB subcontractors/suppliers	$0.00
% - **emerging small business** MWESB subcontractors/suppliers	

SELF-IDENTIFIED or OTHER CERTIFIED MWESB TOTALS

Value - **self-identified or other certified** subcontractors/suppliers	$0.00
% - **self-identified or other certified** subcontractors/suppliers	

OVERALL PROJECT CONTRACT HISTORY

% Value Awarded to MWESB Contractors/suppliers at Initial Contract	#DIV/0!
% Value Awarded to MWESB Contractors/suppliers at Final Contract	#DIV/0!

FOR OFFICIAL USE ONLY:

Date Received by the Campus	
Initials of Campus staff who checked the document	

Individual Contractor/Sub-Contractor/Supplier Data Entry Matrix

Name of MWESB General/ Subcontractor/ Supplier	State of Oregon MWESB Certification Number	Self-Identified or Other Certified	Initial Sub-Contract Value	Sub-Contract value billed within the fiscal year (July 1-June 30)	Final Sub-Contract Value	Minority-Owned	Women-Owned	Emerging Small Business

ATTACHMENT A
PREVAILING WAGE RATES

In compliance with Oregon Prevailing Wage Law, the following is incorporated into this Invitation to Bid (ITB):

The Contractor and all subcontractors shall comply with the provisions of ORS 279C.800 through 279C.870, relative to Prevailing Wage Rates as outlined in Sections C.1 and C.2 of the General Conditions. This ITB and the resulting Contract are subject to the following BOLI wage rate requirements, which are incorporated herein by reference:

- October 1, 2019 PWR Apprenticeship Rates
- October 1, 2019 Prevailing Wage Rate Amendments
- July 1, 2019 Prevailing Wage Rates for Public Works Contracts in Oregon
- July 1, 2018 Definitions of Covered Occupations for Public Works Contracts in Oregon

These BOLI wage rates are available on line at:
http://www.boli.state.or.us/BOLI/WHD/PWR/pwr_state.shtml

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. The Work Contract consists of adding cooling to existing mechanical system, replacing pneumatic controls, replacing air handler fans, installing chill water piping for cooling adds, replacing condenser water cooling tower, and new exhaust fans, and the corresponding electrical requirements for mechanical work at the Radiation Center on the Oregon State University Campus, Corvallis, Oregon. The work must comply with the most current edition of the OSU Construction Standards. OSU Construction Standards are located at http://fa.oregonstate.edu/cpd-standards and are herein incorporated by this reference.

B. Work shall be started within ten (10) calendar days after signing of Contract on behalf of Oregon State University. The Contract may not be signed prior to approval of the Contractor's Certificate of Insurance by Construction Contracts Administration (CCA), Oregon State University. Work shall be completed on or before June 19, 2020.

1.02 CONTRACTORS USE OF PREMISES

A. Contractor shall limit use of the Premises for work and storage to allow for:
   1. Owner occupancy, day and night.
   2. Public use, day and night.
   3. Security.
   4. Safe entry and exit for vehicles and pedestrians.
   5. Fire egress.

B. Coordinate all operations with the Owner's Authorized Representative during the construction period. A 96 hour notification is required prior to scheduled utility shutdowns or street closures, but more lead time is often required to schedule around other critical activities.

C. Limit Contractor's employee parking to locations designated at the Pre-construction Conference.

1.03 OWNER OCCUPANCY

A. The Owner will occupy the Premises during the entire period of construction for the conduct of normal operations. Cooperate with Owner's Authorized Representative in construction operations to minimize conflict and to facilitate the Owner's usage especially in the following areas:
   1. Restricted access and parking.
   2. Use of stairs.
   3. Storage space availability.

B. Conduct operations in such a way to ensure the least inconvenience to the general public, including:
   1. Limitations and easements.
   2. Emergency vehicle access.
   3. Building access to the public, day and night.

1.04 ASBESTOS AND OTHER HAZARDOUS MATERIAL

A. The Owner has made a reasonable attempt to locate and identify asbestos or other hazardous material that may be encountered during the course of the Work.

B. If the Contractor observes or suspects the existence of asbestos, polychlorinated biphenyl (PCB) or other hazardous materials in the structure or components of the building, the Contractor shall immediately stop work and notify the Owner's Authorized Representative.

C. The Owner will arrange for the removal of asbestos, polychlorinated biphenyl (PCB) or other hazardous materials as required by Facilities Services personnel or by separate contract.

D. Schedule ten (10) days of slack or "down" time for the removal of hazardous materials without penalty to Owner for the delay of the Contract.

1.05 LEAD BASED PAINT

A. The Owner may have tested existing paint in the project area and if levels are found the following conditions apply.

B. Contractor shall remove paint as specified for surface preparation and capture removed material for disposal.

C. Contractor shall follow OSHA guidelines involving exposure to workers.

D. Owner will provide containers for Contractor's use at project site.

E. Contractor shall comply with the requirements of DEQ and EPA and shall submit a lead abatement plan.

F. Contractor shall separate lead contaminated material from effluent and water.

G. Owner will dispose of lead paint and effluent resulting from stripping operation.

H. Soil contaminated by stripping operations shall be replaced with topsoil.

END OF SECTION

SECTION 01 23 00

ALTERNATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The alternates described in this Section may be exercised at the option of the Owner within 60 days of the execution of the Contract.

B. It is generally the practice of the Owner to exercise alternates in numerical order.

C. The Owner reserves the right to accept the alternates without regard to order or sequence; but, such acceptance shall not impair the selection of a low, responsible and responsive bidder to whom the Contract may be awarded under an equitable bid procedure.

1.02 QUALITY ASSURANCE

A. For each alternate which is accepted, coordinate the work of the various trades involved, and modify surrounding work as required to complete the project as intended.

B. In the change-in-price figure for each alternate, include incidental costs which are attributable to adjustments in the work of other trades which may be required to achieve the contemplated and final conditions.

C. Questions:
   1. If there is a question regarding the extent, scope, nature, or intent of the alternates, contact the Owner's Authorized Representative for clarification.
   2. Failure on the part of the Contractor to clarify any unclear items shall not relieve the Contractor of the responsibility for performing the selected alternates in accordance with the intent and requirements of the Project Manual and Drawings.
   3. The description of the alternates hereinafter is qualitative and not quantitative; the Contractor shall determine the quantities of labor and materials and the extent of same required to execute the selected alternates in accordance with the intent and requirements of the Project Manual and Drawings.
   4. The applicable Sections of the Specifications apply to the work under each alternate.

1.03 LIST OF ALTERNATES

A. Alternate No. 1: Delete reactor building ASU-1 controls requirement..

B. Alternate No. 2: Delete work associated with exhaust fans EF1 thru EF-4.

END OF SECTION

SECTION 01 24 76

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work of this Section includes forms and procedures for progress payments.

B. Related work specified elsewhere.
   1. For the primary discussion of payments, refer to OSU General Conditions, Section E, as supplemented.
   2. In compliance with OSU General Conditions, Section K, no payments beyond 75% will be made by the Owner before two complete copies of the draft Operation and Maintenance Manuals have been received for review by the Owner.

1.02 APPLICATION FORMS

A. For applications for payment, use sample contract payment request on company letterhead, or AIA Document G702, supported by AIA Document G703, Continuation Sheet, or similar document.

B. Prepare the Schedule of Values in such a manner that each major item of Work and each subcontracted item of Work is shown as a line item broken down in terms of material and labor costs on AIA Document G703, Application Certification of Payment, Continuation Sheet or similar format. The sample continuation sheet shall be the minimum Schedule of Values breakdown.

C. The Schedule of Values shall be submitted for review by the Owner prior to the first application for payment; and may be used when, and only when, accepted in writing by the Owner.

D. Payment request is to include the Contractor's Federal Tax Identification number and return address.

1.03 PAYMENTS

A. The Owner will make progress payments on account of the Contract once monthly for the scheduled duration of the project (i.e. three (3) payments on a three-month project), based on the value of work accomplished or materials on the job site, as stated in the Schedule of Values on the Application and Certificate Payment.

B. Notwithstanding the foregoing, as this project is scheduled to take six (6) months to complete, Owner will only make six (6) payments, plus a final retainage payment, as applicable.

C. Complete and forward Application to the Owner on or about the 15th day of each month for work performed the previous month and include certified payroll statements as specified in the OSU General Conditions.

D. Submit one (1) copy of forms requesting payment to the Owner.

E. Payments will be made on protected materials on hand at the job site properly stored, protected, and insured.

F. Estimated quantities shall be subject to the Owner's review and judgment.

1.04 EARLY PURCHASE AND PAYMENT OF MATERIALS AND EQUIPMENT

A. Order materials and equipment requiring a long lead or waiting time early so as not to delay progress of the Work.

B. The Contractor will be reimbursed for early order materials or equipment upon receipt and verification of quality and quantity against submittals and shipping documents by the Owner's Authorized Representative.

C. Receipt shall be to the job site or stored at Owner's other premises in an orderly and safe manner, secured from normal weather damage.

D. Security remains the responsibility of the Contractor.

END OF SECTION

CONTRACT PAYMENT REQUEST

DATE: _____

TO: University Financial Services
Oregon State University
3015 SW Western Blvd.
Corvallis OR 97333
Email: FacServContracts@oregonstate.edu

Payment Request No. _____Contract No. _____ Period from _____ to _____

Project: _____

Original Contract Amount ..... $_____

Change Orders (Net Amount) ..... $_____

Contract Total to Date ..... $_____

==========

Total Completed and Stored to Date ..... $_____

Less Retainage (5%), if applicable ..... $_____

Total Earned, Less Retainage (if applicable)..... $_____

Less Previous Payments ..... $_____

Net Amount Due this Request ..... $_____

The undersigned Contractor certifies that, to the best of his/her knowledge, information, and belief, the Work covered by this request has been completed in accordance with the Contract Documents, that all amounts have been paid for Work for which previous applications for Payment were issued and payments received from the Owner, and that the amount shown herein is now due.

Contractor:_____

By: _____Date: _____

Federal Tax ID Number:_____

Address:_____

_____

CONTINUATION SHEET

Project Name:

Application No.:

Date:

Period To:

WRN No.:

NOTES:

Amounts are stated to the nearest penny.
Use Column I on Contracts where variable retainage for line items may apply, or if retainage is required.

Change Orders are usually listed as the last items of the basic schedule.

A	B	C	D	E	F	G		H	I
Item No.	**Description of work**	**Scheduled Value**	**Work Completed**		**Materials Presently Stored (Not in D or E)**	**TOTAL Completed & Stored (D+E+F)**	**% Completed (G/C)**	**Balance to Finish (C-G)**	**Retainage**
			From Previous Applications	This Period					
TOTALS									

SECTION 01 25 00

PRODUCT SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General requirements for the Work in relation to substitutions and product options.

B. Submit to the Owner's property insurance carrier shop drawings, samples, and product data (such as manufacturer's standard schematic drawings and other literature) when required by individual Specifications sections.

C. Related Work Specified Elsewhere
   1. Instructions to Bidders.
   2. OSU General Conditions.

1.02 REQUESTS FOR SUBSTITUTIONS

A. Requests for substitution of products in place of those specified shall be in accordance with Instructions to Bidders, and as specified herein.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Investigate proposed products and determine that they are equal or superior in all respects to products specified.

B. Provide same guarantee for accepted substitutions as for products specified.

C. Coordinate installation of accepted substitutions into the Work, making such changes as may be required for the Work to be complete in all respects.

1.04 SUBSTITUTIONS DURING BIDDING

A. Submit two (2) copies of the following information with each request to the Owner:
   1. CSI substitution request form.
   2. Comparison of proposed substitution with product, material or system specified.
   3. Complete data, substantiating compliance of proposed substitution with the Contract Documents.
   4. Test numbers and supporting reports, indicating compliance with referenced standards.
   5. Evidence that warranty requirements are acceptable.
   6. Details indicating specific deviations proposed for the substitution.
   7. Reference and applicable Specification sections.
   8. Applicable product samples.

B. All substitution requests shall be received in the Owner's office no less than twelve (12) calendar days before bid opening. Requests received after this date will not be considered.

1.05 SUBSTITUTIONS DURING CONSTRUCTION

A. Substitutions will normally not be considered after date of Contract except when required due to unforeseen circumstances.

B. Within a period of thirty (30) days after date of Contract, the Owner may, at its option, consider formal written requests for substitution of products in place of those specified, when submitted in accordance with the requirements stipulated herein.

C. One or more of the following conditions must be documented in any such request:
   1. Required for compliance with final interpretation of code or insurance requirements.
   2. Required due to unavailability of a specified product.
   3. Required because of the inability of the specified product to perform properly or to fit in the designated space.
   4. Substitution would be substantially in the best interest of the Owner in terms of cost, time, or other considerations.

1.06 SUBSTITUTIONS NOT PERMITTED

A. If implied on submittals without first requesting approval thereof.

B. If acceptance will require substantial revision of the Contract Documents.

END OF SECTION

SUBSTITUTION REQUEST FORM

TO: _____

PROJECT: _____

SPECIFIED ITEM:

_____	_____	_____	_____
Section	Page	Paragraph	Description

The undersigned requests consideration of the following:

PROPOSED SUBSTITUTION: _____

Attached data includes product description, specifications, drawings, photographs, performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes description of changes to Contract Documents which proposed substitution will require for its proper installation.

The undersigned states that the following paragraphs, unless modified on attachments, are correct:

1. The proposed substitution does not affect dimensions shown on Drawings.

2. The undersigned will pay for changes to the building design, including engineering design, detailing and construction costs caused by the requested substitution.

3. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.

4. Maintenance and service parts will be locally available for the proposed substitution.

The undersigned further states that the function, appearance and quality of the Proposed Substitution are equivalent or superior to the Specified Item.

Submitted by:

Signature _____

Firm _____

Address _____

_____

Date _____

Telephone _____

Attachments:

For use by Design Consultant:

☐ Accepted ☐ Accepted as noted

☐Not Accepted ☐ Received too late

By _____

Date _____

Remarks _____

SECTION 01 31 19

PROJECT MEETINGS

PART 1 GENERAL

1.01 PRE-CONSTRUCTION MEETING

A. Architect/Engineer/Designer, Contractor and Owner will meet prior to start of the Work (within seven (7) days after notice to proceed) to discuss at least the following topics and any others of mutual interest.
   1. Schedule of Values
   2. Permit Status/tree protection/erosion control
   3. List of sub-contractors
   4. Job inspections.
   5. Early purchase of, and/or lead time requirements for material and equipment/prepurchase of equipment
   6. Monthly payment date/SOP for pay requests
   7. Portion of site to be occupied by construction.
   8. Parking/Staging areas
   9. Non-smoking campus requirements
   10. Maintenance of access and safety.
   11. Processing of field decisions and change orders
   12. Labor provisions/labor rates for subs
   13. Material submittals/deferred submittals
   14. Owner access during construction.
   15. Review of Contract Documents/review ADA requirements/cross-slopes
   16. Coordination procedures and separate contracts.
   17. Progress schedules.
   18. Critical Work sequencing.
   19. Safety and emergency procedures/24 hour contact numbers
   20. Security procedures.
   21. Hazardous materials.
   22. Progress meetings.
   23. Contract close-out.

B. Location of Meeting: Project site

1.02 PROGRESS MEETINGS

A. The Contractor will schedule and administer progress meetings and will:
   1. Prepare agendas.
   2. Schedule progress meetings, frequency, time and day to be determined during pre-construction meeting.
   3. Make physical arrangements for and preside at meetings.
   4. Record minutes and include decisions.
   5. Distribute copies of minutes to participants within four (4) days after meetings.

B. Location of Meetings: Project site.

C. Attendance:
   1. The Owner or Owner's Authorized Representative.
   2. Contractor.
   3. Subcontractors affected by agenda.
   4. Project Architect/Engineer/as necessary.
   5. Owner will attend meeting to ascertain Work is expedited consistent with progress schedule and with Contract Documents.

D. Minimum Agenda:
   1. Review and approve minutes from previous meeting.
   2. Review Work progress since previous meeting.
   3. Discuss field observations, and problems.
   4. Review delivery schedules, construction schedule, and identify problems which impede planned progress.
   5. Review proposed changes.
   6. Material submittals.
   7. Note all new subcontractors performing Work at the job site.

END OF SECTION

SECTION 01 33 23

SHOP DRAWINGS, PRODUCT DATA, SAMPLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submit to the Owner shop drawings, samples, and product data (such as manufacturer's standard schematic drawings and other literature) when required by individual Specifications sections.

B. Related Work Specified Elsewhere
   1. Instructions to Bidders.
   2. OSU General Conditions.

1.02 SUBMITTAL SCHEDULING

A. For items requiring review by the Owner only, submittals shall be sent to the Owner at least 15 calendar days before the date each is required for fabrication or installation.

B. Submittals to be reviewed by Owner's consultants shall be sent to the Owner at least 20 calendar days before the date each is required for fabrication or installation.

C. Submittals to be reviewed by Owner's property insurance carrier shall be sent to Owner as directed in individual specification sections.

D. Submittals involving Substitution requests or other modifications requiring review by the Owner and/or the Owner's consultants shall be sent to the Owner at least 20 calendar days before the date each is required for fabrication or installation.

1.03 SUBMITTAL CONTENT AND FORMAT

A. General Requirements:
   1. Shop Drawings: Submit in electronic format and, if requested by Owner's Authorized Representative, submit one reproducible transparency and 1 print of each drawing.
   2. Product Data: Submit electronically, and if requested by Owner's Authorized Representative, up to 6 hard copies.
   3. Samples: Submit the number and type stated in each Specification Section. Submit a minimum of three sets of color samples where color selection is required.
   4. Submittals shall include:
      a. Date and revision dates return date requested.
      b. Project title and number.
      c. The names of the Contractor, subcontractor, supplier, and manufacturer.
      d. Identification of product or material, with Specification Section number.

e. Relation to adjacent critical features of work or materials.
f. Field dimensions, clearly identified as such.
g. Applicable standards, such as ASTM number or Federal Specification.
h. Identification of deviations from Contract Documents, and for products accompanied by Substitution request as required by Section 01 25 00.
i. Contractor's stamp legibly signed, essentially as follows:
1) The undersigned, acting on behalf of the Contractor, certifies that this submittal has been reviewed and is approved; products have been verified as being as specified, field measurements and field construction criteria have been or will be coordinated, and the submittal is in compliance with Contract Documents.

5. Re-submission Requirements:
a. Revise initial drawings as required and resubmit as specified for initial submittal.
b. Indicate on drawings any changes which have been made other than those requested by the Owner or the owner's consultants.
6. The Owner may return without review any submittal not meeting the requirements listed above.

B. Shop Drawings:
1. Present data in a clear and thorough manner.
2. Details shall be identified by reference to sheet and detail, schedule or room numbers shown on Contract Documents.
3. Structural items shall be identified by location in the completed structure. Identify details by reference to contract sheet and detail numbers.
4. Minimum sheet Size: 8 ½ x 11".

C. Product Data:
1. Manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard descriptive data:
a. Clearly mark each copy to identify pertinent product or models.
b. Show dimensions, weights, and clearances required.
c. Show performance data consisting of capabilities, ROM, KW, pressure drops, design characteristics and consumption; conforming as closely as possible to the test methods referenced in the Plans and Specifications.
d. Show wiring or piping diagrams and controls.
2. Manufacturer's standard schematic drawings and diagrams:
a. Modify to delete information which is not applicable.
b. Supplement standard information to provide information specifically applicable to the Work.

D. Samples:
1. Insure that samples are of sufficient size to indicate the general visual effect or color.
2. Where samples must show a range of color, texture, finish, graining, or

other property, submit sets of pairs illustrating the full scope of this range.

3. One (1) sample or one (1) set of approved samples will be retained by the Owner; final work will be measured against approved samples.

1.04 QUALITY ASSURANCE

A. Process submittals in ample time for review, as applicable, so as to not delay the Work. All submittals shall be received by the Owner within ten (10) days after pre-construction.

1.05 DEFINITIONS

A. The Owner will mark reviewed materials as follows:
   1. “No Exception Taken,” which means fabrication, manufacture and/or installation may proceed.
   2. “Make Revisions Noted,” which means fabrication, manufacture and/or installation may proceed with revisions as noted.
   3. “Revise and Resubmit,” which means that fabrication, manufacture and/or installation may not proceed.
   4. “Rejected,” which means do not proceed; make arrangements for the review of the proposed Work with the Owner as soon as possible.

1.06 PROCESSING

A. Review submittals, make necessary corrections, and become familiar with the content of the submittals.

B. Mark each item with Contractor’s stamp.

C. Accompany submittals with a transmittal letter bearing the project name, Contractor’s name, number of items, and other pertinent data.

D. Keep one copy of each reviewed submittal on the job site at all times.

E. Be responsible for obtaining and distributing prints of shop drawings to the various suppliers, and the Owner once review process has been completed. Make prints of reviewed shop drawings only from transparencies which carry the appropriate stamp and endorsement.

END OF SECTION

SECTION 01 42 13

ABBREVIATIONS AND SYMBOLS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Words which may be found elsewhere in the Project Manual and Drawings are abbreviated in accordance with the standards set forth in the following table:

A/C	air conditioning
AB	anchor bolt
AC	asphaltic concrete
ACT	acoustical tile
AD	area drain
ADD	addendum
ADD'L	additional
ADH	adhesive
AFF	above finish floor
AGG	aggregate
AL	aluminum
ALLOW	allowable
ALT	alternate
ANOD	anodized
AP	access panel
APPRX	approximate
ARCH	architect(ural)
ASPH	asphalt
AUTO	automatic
AVE	avenue
BD	board
BIT	bituminous
BLDG	building
BLKG	blocking
BM	bench mark, beam(s)
BOT	bottom
BRZ	bronze
BS	both side
CB	catch basin
CEM	cement
CF	cubic foot
CFOI	contractor furnished owner installed
CG	corner guard
CH	ceiling height
CI	cast iron
CJ	control joint
CKBD	chalkboard
CL	centerline
CLG	ceiling
CLR	clear(ance)
CM	construction manager
CMT	ceramic mosaic (tile)
CMU	concrete masonry unit
COL	column
COM	communications
CONC	concrete
CONN	connect(ion)
CONST	construction
CONT	continuous or continue
CONTR	contract(or)
CPT	carpet
CRS	course(s)
CS	countersink
CSMT	casement
CT	ceramic tile
CTR	center
CVG	clear vertical grain
CW	cold water
CWT	ceramic wall tile
CY	cubic yard
D	depth
DEMO	demolish, demolition
DEP	depressed

DF	drinking fountain
DIA	diameter
DIAG	diagonal
DIM	dimension
DISP	dispenser
DIV	division
DL	dead load
DMT	demountable
DN	down
DP	dampproofing
DR	door
DS	downspout
DT	drain tile
DTL	detail
DW	dumbwaiter
DWG	drawing(s)
DWR	drawer
EA	each
EB	expansion bolt
EF	each face
EJ	expansion joint
EL	elevation
ELEC	electric(al)
EMBED	embedment
EMER	emergency
ENCL	enclose(ure)
EP	electrical panel board
EQ	equal
EQUIP	equipment
EST	estimate
EVT	equiviscious temperature
EW	each way
EWC	electric water cooler
EX.EXIT	existing
EXH	exhaust
EXP	exposed
EXT	exterior
FA	fire alarm
FAF	fluid applied flooring
FARF	fluid applied resilient floor
FAS	fasten, fastener
FBD	fiberboard
FBT	finished blowing temperature
FD	floor drain, fire damper
FE	fire extinguisher
FEC	fire extinguisher cabinet
FF	factory finish
FGL	fiberglass
FHMS	flathead machine screw
FHWS	flathead wood screw
FIN	finish(ed)
FLCO	floor cleanout
FLR	floor(ing)
FLUR	fluorescent
FND	foundation
FOC	face of concrete
FOIC	furnished by owner/installed by contractor
FOIO	furnished by owner/installed by owner
FOM	face of masonry
FP	fireproofing, flash point
FPHB	freeze-proof hose bib
FR	fire resistive, fire rated
FRM	frame(d), (ing)
FS	full size
FSS	finished structural slab
FT	foot
FTG	footing
FTS	finished topping slab
GA	gage, gauge
GALV	galvanized
GB	grab bar or gypsum board
GC	general contractor
GI	galvanized iron
GL	glass, glazing
GLS	glass resin wall surfacing
GP	gypsum
HB	hose bib
HBD	hardboard
HC	hollow core
HD	heavy duty
HDR	header
HDW	hardware
HM	hollow metal
HOR	horizontal

HP	high point
HR	hour
HT	height
HTG	heating
HVAC	heating, ventilating, air conditioning
HWD	hardwood
HWH	hot water heater
ID	inside diameter, identification
IN	inch
INCIN	incinerator
INCL	include(d), ion)
INT	interior
INV	invert
JB	junction box
JC	janitor's closet
JT	joint
KD	kiln dried
KCP	Keene's cement plaster
KO	knockout
KP	kick plate
LAB	laboratory
LAM	laminate(d)
LAV	lavatory
LBS	pounds
LH	left hand
LL	live load
LONGIT	longitudinal
LP	low point
LW	lightweight
MAX	maximum
MB	machine bolt
M. MECH	mechanic(al)
MFR	manufacture(r)
MH	manhole
Min	minimum, minute
MISC	miscellaneous
MO	masonry opening
MO#	model number
MOD	modular
MPH	miles per hour
MS	machine screw
MTL	metal
MULL	mullion
MWP	membrane waterproofing
NAT	natural, natural finish
NIC	not in contract
NO	number
NOM	nominal
NTS	not to scale
OA	overall
OBS	obscure
OC	on center(s)
OD	outside diameter
OF	overflow
OFCI	owner furnished contractor installed
OFOI	owner furnished owner installed
OHMS	ovalhead machine screw
OHWS	ovalhead wood screw
OPG	opening
OPP	opposite
OZ	ounce(s)
P	paint(ed)
PB	push button
PCF	pounds per cubic foot
PCP	putting coat plaster
PERF	perforate(d)
PL	plate, property line
PLAM	plastic laminate
PLAS	plaster
PNL	panel
PP	push plate
PR	pair
PREP	prepare
PSF	pounds per square foot
PSI	pounds per square inch
PT	point, pressure treated
PTN	partition

PVC	polyvinyl chloride
PWD	plywood
QT	quarry tile
R	rise
RA	return air
RAD	radius
RCP	reflected ceiling plan
RD	roof drain
REF	reference
REFR	refrigerator
REINF	reinforce(ing)
REQ	required
RET'G	retaining
REV	revision(s), revised
RH	right had
RM	room
RO	rough opening
RSF	resilient sheet flooring
SC	solid core
SCHED	schedule
SEC	section
SF	square feet (foot)
SHT	sheet
SHTHG	sheathing
SIM	similar
SL	sleeve
SOG	slab on grade
SPEC	specification(s)
SQ	square
SS	storm sewer
S4S	finished 4 sides
SD	storm drain
ST	steel, street
ST ST	stainless steel
STD	standard
STR	structural
SUPP	supplement
SUPT	support
SUSP	suspended
SV	sheet vinyl
T	tread
TBM	top bench mark
T&G	tongue and groove
TB	towel bar
TC	top of curb
TEL	telephone
TEMP	tempered
THK	thickness
TKBD	tackboard
TO	top of
TP	top of paving
TRANS	transverse
TS	top of slab
TV	television
TW	top of wall
TYP	typical
UNO	unless noted otherwise
VAT	vinyl asbestos tile
VB	vapor barrier
VCT	Vinyl Composition Tile
VERT	vertical
VG	vertical grain
VIF	verify in field
VWC	vinyl wall covering
W	width, wide, water
W/	with
W/O	without
WC	water closet
WD	wood, wood finish
WP	waterproof(ing)
WNS	wainscot
WR	water resistant
WS	waterstop
WW	window wall
WWC	wood wall covering
WWF	woven wire fabric

B. Words which may be found elsewhere in the Project Manual and Drawings are abbreviated in accordance with the standards set forth in the following table:

& and
λ angle
@ at
ι diameter, round
" inches
: is, shall b
' feet
ζ perpendicular
/ per
% percent
# pound, number
X by (as in 2 by 4)

END OF SECTION

SECTION 01 42 16

DEFINITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Words which may be found elsewhere in the Contract Documents are defined in accordance with the standards set forth in the following table:

Approve:

Where used in conjunction with Architect's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be limited to the Architect's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect be interpreted as a release of Contract requirements.

As Detailed, As Shown:

Where “as detailed”, “as shown” or words of similar importance are used, it shall be understood that reference to the Drawings accompanying the Specifications is made unless otherwise stated.

As Directed, As Required, As Authorized, As Reviewed, As Accepted:

Where “as directed”, “as required”, “as authorized”, “as reviewed”, “as accepted” or words of similar importance are used, it shall be understood that the direction, requirement, permission, authorization, review, or acceptance of the Architect is intended, unless otherwise stated.

As Indicated:

Where “as indicated” is used it shall be understood that reference to Drawings and/or Specifications is made unless otherwise stated.

Directed, Requested, etc.:

Terms such as "directed," "requested," "authorized," "selected," will be understood as "directed by Architect," "requested by Architect," and similar phrases shall not be interpreted to extend Architect's responsibility into Contractor's responsibility for construction supervision.

Furnish:

Except as otherwise defined in greater detail the term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

Indicated:

The term "indicated" is a cross-reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications

and to similar means of recording requirements in Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for purpose of helping reader locate cross-reference and no limitation of location is intended except as specifically noted.

Install:

Except as otherwise defined in greater detail, the term "install" is used to describe operations at project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

Installer:

The term "installer" is defined as the entity (person or firm) engaged by Contractor, or its subcontractor or subsubcontractor for performance of a particular unit of Work at project site, including installation, erection, application and similar required operations. It is a general requirement that such entities (Installers) be expert in operations they are engaged to perform.

Provide:

Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

END OF SECTION

SECTION 01 42 19

REFERENCE STANDARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Quality Assurance.

B. Location of References.

C. Schedule of References.

1.02 QUALITY ASSURANCE

A. For products or quality of work 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.

B. Conform to reference standard by date of issue current on date of Contract Documents.

C. General Applicability of Standards: Except where Contract Documents include more stringent requirements, applicable standards of the construction industry have the same force and effect as if bound or copied directly into Contract Documents.

D. Such standards are made a part of the Contract Documents by reference.

E. Individual sections indicate which codes and standards the Contractor must keep at the project site, available for reference.

F. Referenced industry standards take precedence over standards which are not referenced but recognized in industry as applicable.

G. Non-referenced standards are not directly applicable to the Work, except as a general requirement of whether the Work complies with standards recognized in the construction industry.

1.03 LOCATION OF REFERENCES

A. Valley Library, Oregon State University.

1.04 SCHEDULE OF REFERENCED ASSOCIATIONS

AIA American Institute of Architects

WWW.AIA.ORG

AISC American Institute of Steel Construction
WWW.AISC.ORG

AISI American Iron and Steel Institute
WWW.STEEL.ORG

ANSI American National Standards Institute
WWW.ANSI.ORG

APA American Plywood Association
WWW.APAWOOD.ORG

ASHRAE American Society of Heating, Refrigerating, and Air Conditioning Engineers
WWW.ASHRAE.ORG

ASTM American Society for Testing and Materials
WWW.ASTM.ORG

AWPA American Wood Protection Association
WWW.AWPA.COM

AWS American Welding Society
WWW.AWS.ORG

BIA Masonry Institute of America
WWW.MASONRYINSTITUTE.ORG

BOLI Oregon Bureau of Labor and Industries
WWW.BOLI.STATE.OR.US

CCB Construction Contractors Board
WWW.OREGON.GOV.CCB/

CDA Copper Development Association
WWW.COPPER.ORG

CISPI Cast Iron Soil Pipe Institute
WWW.CISPI.ORG

CSI Construction Specification Institute
WWW.CSINET.ORG

DEQ Department of Environmental Quality (Oregon)
WWW.OREGON.GOV/DEQ/

DHI	Door and Hardware Institute WWW.DHI.ORG
DOT	Department of Transportation WWW.DOT.GOV
EPA	U.S. Environmental Protection Agency WWW.EPA.GOV
FM	Factory Mutual System WWW.FMGLOBAL.COM
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) WWW.GSA.GOV/PORTAL/CONTENT/103856
IBC	International Building Code WWW.ICCSAFE.ORG
ICBO	International Conference of Building Officials PUBLICECODES.CITATION.COM/ICOD/IBG/INDEX.HTM
IRS	Internal Revenue Service WWW.IRS.GOV
ISA	Instrumentation Systems and Automation Society WWW.ISA.ORG
NAAMM	National Association of Architectural Metal Manufacturers WWW.NAAMM.ORG
NBFU	National Board of Fire Underwriters WWW.NFPA.ORG
NEC	National Electric Code WWW.NECPLUS.ORG
NEMA	National Electrical Manufacturers' Association WWW.NEMA.ORG
NESC	National Electrical Safety Code WWW.IEEE.ORG
NFPA	National Fire Protection Association WWW.NFPA.ORG

NRCA	National Roofing Contractors' Association WWW.NRCA.NET
OAR	Oregon Administrative Rules ARCWEB.SOS.STATE.OR.US/404.HTML
OESP	State of Oregon Electrical Specialty Code http://www.bcd.oregon.gov/programs/online_codes.html
ORS	Oregon Revised Statutes LANDRU.LEG.STATE.OR.US/ORS/
OSHA	Occupational Safety and Health Administration WWW.OSHA.GOV
OSSC	Oregon Structural Specialty Code http://www.bcd.oregon.gov/programs/online_codes.html
PS	Product Standard STANDARDS.GOV/STANDARDS.CFM
SDI	Steel Door Institute WWW.STEELDOOR.ORG
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association WWW.SMACNA.ORG
SPRI	Single Ply Roofing Institute WWW.SPRI.ORG
SSPC	Steel Structures Painting Council WWW.SSPC.ORG
SWRI	Sealing, Waterproofing and Restoration Institute WWW.SWIRONLINE.ORG
UBC	Uniform Building Code (See ICBO)
UFC	Uniform Fire Code WWW.NFPA.ORG
UL	Underwriters' Laboratories, Inc. WWW.UL.COM
UMC	Uniform Mechanical Code WWW.UBC.COM

UPC	Uniform Plumbing Code WWW.UBC.COM
WHL	Warnock Hersey Laboratories WWW.INTEK.COM/MARKS/WH/
WCLIB	West Coast Lumber Inspection Bureau WWW.WCLIB.ORG
WWPA	Western Wood Products Association WWW.WWPA.ORG

END OF SECTION

SECTION 01 45 00

QUALITY CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Codes, regulations and permits.

B. Procedures for quality control.

1.02 OWNER RESPONSIBILITIES

A. Owner will employ and pay for services of an independent testing laboratory to perform inspection, sampling and testing as required by local building authority.

B. Owner's Authorized Representative will provide on-site observation during construction.

1.03 CODES, REGULATIONS AND PERMITS

A. All Work shall conform with the Oregon Structural Specialty Code (OSSC) based on the International Building Code (IBC), as amended by the State of Oregon Building Codes Division and the edition designated by the governing authority.

B. Contractor shall comply with all applicable state and local construction codes.

C. References to codes, Specifications and standards referred to in the Contract Documents shall mean, and are intended to be, the latest edition, amendment or revision of such reference standard in effect as of the date of these Contract Documents.

D. The Owner shall be responsible for all permits and City of Corvallis plan review fees; the Contractor shall be responsible for all licenses and associated fees required for the Project.

E. Contractor shall arrange and attend all required permit inspections and furnish evidence of approved City inspection reports per Section 01 77 00.

1.04 QUALITY OF WORK

A. It is the true and specific intent of these Specifications that quality of Work on all phases of the construction and embracing all the trade sections shall be of high quality performed by workers skilled in their trade and performing their Work only according to the standard of best practice of the trade.

B. All manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with manufacturer's directions unless otherwise specified.

C. If Work is required in a manner to make it impossible to produce first quality Work, or should discrepancies appear among Contract Documents, request interpretation from Architect before proceeding with Work.

D. Failure to secure interpretation may cause rejection by Architect or owner of installation.

1.05 LAYOUT

A. Be responsible for properly laying out the Work and for lines and measurements for the Work.

B. Verify the figures shown on the drawings before laying out the Work and report errors or inaccuracies to the Architect before commencing Work.

C. Strict compliance with maximum slopes is required. Accessible parking spaces and adjacent access aisles with slope exceeding 2% in any direction, as determined by OSU, shall be removed and replaced by the contractor at their expense.

D. Strict compliance with maximum slopes is required. New sidewalks exceeding 1:20 slope or with cross slope exceeding 2%, as determined by OSU, shall be removed and replaced by the contractor at their expense. Ramps exceeding 1:16 slope or with cross slope exceeding 2%, as determined by OSU, shall be removed and replaced by the contractor at their expense.

1.06 SUPERVISION

A. The Contractor shall maintain effective supervision on the project at all times Work is being performed.

B. The superintendent shall be the same person throughout the project and shall attend the preconstruction conference.

1.07 INSPECTIONS AND TESTING

A. Contractor shall notify the Owner at least twenty-four (24) hours in advance of any required progress inspection or final inspection including final punch list inspection.

B. Cooperate with laboratory personnel, provide access to Work and furnish incidental equipment material and labor required for field testing and sample taking.

1.08 EVALUATION OF TESTS AND INSPECTIONS

A. Results of laboratory and/or field control tests and inspections shall be the principal basis upon which satisfactory completion of Work shall be judged.

B. If results of tests and inspections indicate Work is below requirements of Contract Documents, that portion of Work is subject to rejection.

1.09 ADJUSTMENTS

A. Remove and replace Work so rejected at Contractor’s expense including costs of subsequent tests and inspections until Work meets requirements of Contract Documents.

B. The Owner reserves the right to perform any testing as may be required to determine compliance with the Contract Documents.

C. Costs for such testing will be the Owner's responsibility unless testing indicates noncompliance. Cost for such testing indicating noncompliance shall be borne by the Contractor.

D. Noncomplying Work shall be corrected and testing will be repeated until the Work complies with the Contract Documents.

E. Contractor will pay costs for retesting noncomplying Work.

END OF SECTION

SECTION 01 51 00

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section specifies requirements for temporary services and facilities, including utilities, construction and support facilities, security and protection.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction.

B. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition".

C. Electrical Service: Comply with NEMA, NEC and UL standards and regulations for temporary electric service; install service in compliance with National Electric Code (NFPA 70).

D. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use; obtain required certifications and permits if required.

1.03 PROTECTION

A. Protect sidewalks, asphalt paving, concrete, trees, shrubs, and lawn areas at all times from damage resulting from construction activities.

B. Prevent materials from clogging catch basins and yard drains; leave drains clean and in proper working condition.

C. Protect Existing Irrigation Systems:
   1. In the event damage occurs to an underground irrigation system as a direct result of a Contractor's activities, the Contractor shall repair/replace or be assessed a charge at the discretion of the Owner.
   2. If repairs are to be made by the Contractor, the repairs will be inspected by the Owner’s Authorized Representative prior to backfilling.
   3. Any galvanized pipe that requires repair shall be repaired at a threaded coupling, not by use of a compression coupling.

D. Protect Existing Air Handling Systems:
   1. Contractor shall be responsible for protection of the cleanliness of the existing air handling system at all times. This protection shall include:
      a. During site work or building demolition, prefilters shall be provided and maintained on all building outside air intakes at all times throughout the construction duration.
      b. During any interior work that may create dust in the interior space and

adjacent corridor/hallways, air filters shall be provided and maintained on all affected air return and exhaust grilles. Where air flow in or out of the space is not required, all air duct openings shall be temporarily blanked off with plywood or sheet metal.

c. Prior to starting any work, the Contractor shall record and submit to the Owner's Authorized Representative, pressure readings across all existing air handler air filter banks before installation of new prefilters.
d. Upon completion of all Work affecting existing air handling systems, the Contractor shall remove all temporary filters, covers and associated parts and restore the system to its original operating condition unless otherwise stated elsewhere in the Contract Documents

E. Clean, repair, resurface, or restore existing surfaces to their original, or better, condition, or completely replace such surfaces to match existing, where damaged by construction operations.

F. Security is the responsibility of the Contractor.

G. Construction Debris:
1. Debris shall not be allowed to remain around the buildings during performance of Work, but shall be disposed of as rapidly as it accumulates.
2. On completion of Work, the buildings and grounds shall be left in a condition that is equal to or better than original condition.
3. In case of failure to do so, the Owner may remove rubbish and charge the cost to the Contractor.

H. The Contractor shall manage a safe job environment for both the safety of all the people around the Work site as well as the safety of the Owner's and general public's property.

I. The Contractor shall provide and maintain suitable barricades, shelters, lights, and danger signals during the progress of the Work; they shall meet the requirements of the local building code and OSHA.

1.04 DRAINAGE

A. Verify that all rain drains in the construction areas are in working order and notify the Owner's Authorized Representative in writing of any rain drains that are plugged, prior to the start of the Work.

B. Start of Work will be considered as acknowledgment that all drains are clear and in good working order.

C. All drains shall be left in a clean and proper working condition.

1.05 CONSTRUCTION PROJECT SAFETY FORM

A. Contractor shall submit to the Owner, prior to signing the Contract, the completed "Construction Project Safety Form", which is provided with instructions at the end of this Section.

1.06 TEMPORARY UTILITIES

A. Temporary Utilities:
   1. Prepare a schedule indicating dates for implementation and termination of each temporary utility.
   2. At the earliest feasible time, when acceptable to the Owner, change over from use of temporary service to use of the permanent service.

B. Conditions of Use:
   1. Keep temporary services and facilities clean and neat in appearance.
   2. Operate in a safe and efficient manner.
   3. Take necessary fire prevention measures.
   4. Do not overload facilities or permit them to interfere with progress.
   5. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. Electrical Service:
   1. Service limited to 20 amp 120V circuits will be paid for by the Owner.
   2. Connection to the service shall be the responsibility of the Contractor, with the Owner's approval.
   3. Coordinate with the Owner's Authorized Representative.

D. Water Service:
   1. Service in reasonable quantities for the Project will be paid for by the Owner.
   2. Connection to the service shall be the responsibility of the Contractor, with the Owner's approval.
   3. Coordinate with the Owner's Authorized Representative.

1.07 TEMPORARY SUPPORT FACILITIES

A. Temporary Sanitary Facilities:
   1. Provide and maintain an adequate number of facilities for the use of all persons employed on the Work during construction.
   2. Provide enclosed, weatherproof facilities with heat as required.
   3. Use of new or existing Owner's facilities will not be permitted.

B. Temporary Heat and Ventilation:
   1. As necessary, provide temporary heat and ventilation required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

C. Telephone Equipment: Provide telephone communications at project site.

D. Existing Services:
   1. Do not interrupt any existing service.

2. Prior request and approval of the Owner's Representative will enable the Owner to shut down any utility required by the Work.
3. Contractor shall not shut down utilities.

1.08 TEMPORARY BARRIERS AND ENCLOSURES

A. Provide barriers and fencing to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage.

B. Provide Commercial grade chain link fence construction.

C. Provide 6 foot high fence around construction site as directed by Owner’s Authorized Representative; equip with vehicular and pedestrian gates with lock.

D. Exterior Closures: Provide temporary secured, weather-tight closures at exterior openings, to permit acceptable working conditions and protection of the Work.

E. Interior Closures:
1. Provide temporary floor to ceiling partitions (not plastic sheeting) and ceilings as required to separate work areas from Owner occupied areas, to prevent penetration of dust and moisture into Owner occupied areas, to reduce construction noise, and to prevent damage to existing materials and equipment.
2. Paint surfaces exposed to view from Owner occupied areas.

1.09 ODORS

A. Work that causes excessive odors shall be performed only after coordination with the Owner’s Authorized Representative. Filtering of air intakes to units may be required to prevent odors and vapors from entering the buildings.
B. Contractor shall provide 7 days advance notice to the Owner’s Authorized Representative in order for advance notice to be forwarded to building occupants. Work stoppage may occur if advance notification has not been coordinated or odors and vapors from the work are found to generate complaints from building occupants.

1.10 FIRE SAFETY

A. Ensure that required exit routes remain unobstructed while building is occupied.

B. Abide by all fire safety requirements for buildings under construction, alteration or demolition as required by Article 87, of the Uniform Fire Code as adopted by the State of Oregon.

C. An emergency telephone shall be provided on site. Cellular telephone equipment is acceptable.

D. Fire Suppression Equipment:
1. Install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers", and NFPA 241 "Standard for Safeguarding Construction, Alterations and

Demolition Operations".

2. Maintain equipment in working condition with current inspection certificate attached to each.
3. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell.
4. Store combustible materials in containers in fire-safe locations.
5. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for fighting fires.
6.
6. Provide continual supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.
7. When possible, relocate hot work to a designated hot work area.
8. If the materials or equipment cannot be relocated to a designated hot work area, use the least hazardous form of hot work that will get the job done and prepare the area properly.
9. Manage mobile hot work using the formal hot work permit system. (mentioned in the next bullet point and also a directive in the OSU Hot Work Safety Program)
10. Make sure both fire protection and hot work equipment work properly.
11. Train all personnel involved in hot work operations and activities so that they have the understanding, knowledge, and skills necessary to safely perform their jobs.

1.11 CONSTRUCTION AIDS

A. Scaffolding: comply with applicable OSHA requirements.

B. Material Handling Equipment:
   1. Provide necessary cranes, hoists, towers, or other lifting devices.
   2. Use only experienced operators.
   3. Remove equipment as soon as possible after task is ended.
   4. Coordinate placement of such equipment with Owner’s Authorized Representative.
   5. Obtain required permits and meet requirement of governing authorities regarding applicable regulations.

C. Materials or debris shall not be allowed to free fall from building.

D. The use of chutes or conveyors must be approved by Owner.

1.12 TEMPORARY CONTROLS

A. Water Control:
   1. Maintain excavations free of water.
   2. Provide, operate, and maintain necessary pumping equipment.

B. Protection:
   1. Protect installed Work and provide special protection where specified in individual specification sections.

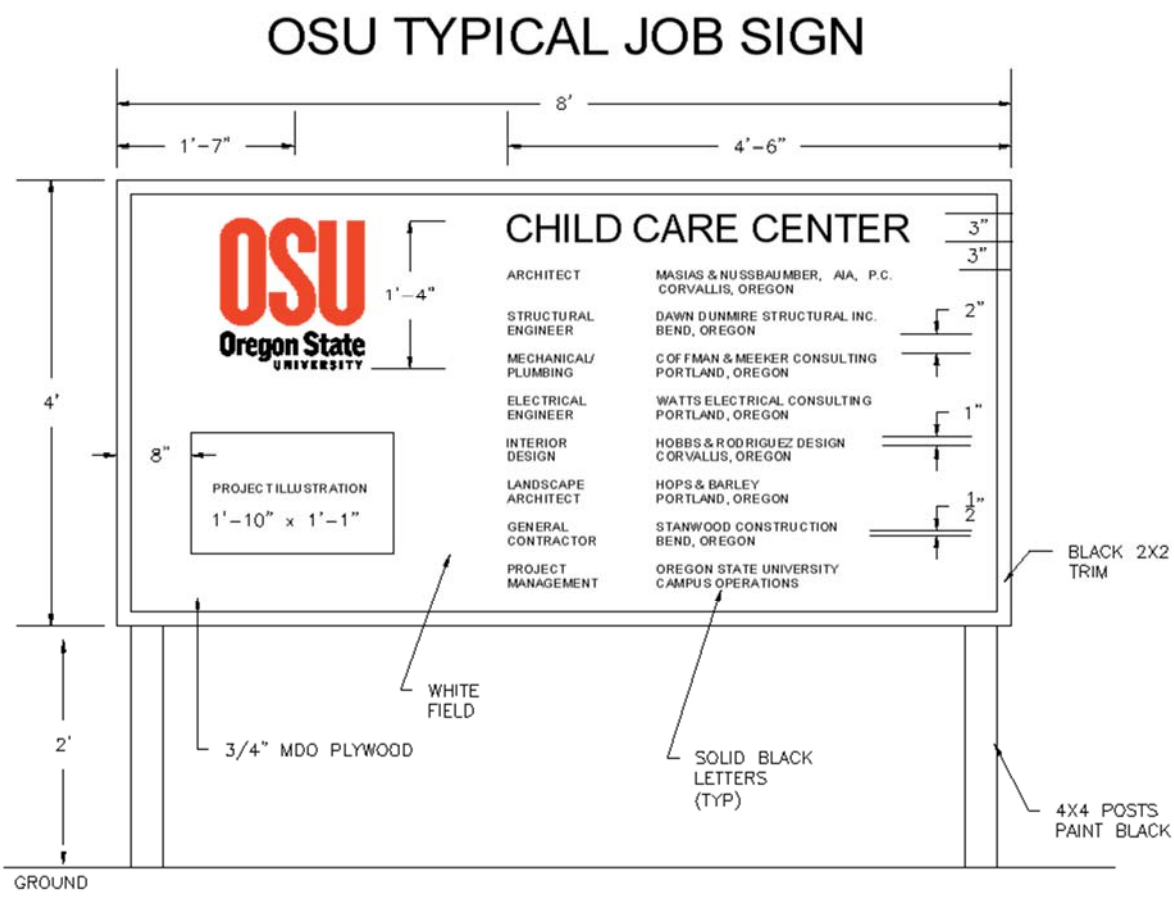
2. Prohibit traffic or storage upon waterproofed or roofed surfaces.

C. Security:
1. Provide security and facilities to protect Work and existing facilities and Owner's operations from unauthorized entry, vandalism, or theft.
2. Coordinate operations with Owner's Authorized Representative.

D. Temporary Traffic Control /Pedestrian Accessibility
1. A continuous route for all pedestrians, including persons with disabilities and bicyclists, shall be maintained at all times. When existing pedestrian facilities are disrupted, closed, or relocated in a construction zone, temporary pedestrian facilities shall be provided.
2. Temporary pedestrian facilities should be safe and accessible. There should be no curbs or abrupt changes in grade that could cause tripping or be a barrier to wheelchair use.
3. Signage shall be provided directing people to the temporary accessible route. The signage shall include the International Symbol of Accessibility.
4. Contractors shall not block temporary walkways with vehicles, equipment, construction materials, signs, trash, or other objects that might prohibit pedestrian passage.
5. Construction equipment and equipment operation must be separated from any open walkways. At construction zones, pedestrian fences or other protective barriers shall be provided to prevent access into the construction zone.

1.13 PROJECT SIGNAGE

A. Contractor is permitted to post only one project identification sign based on the following example:



1.14 PREPARATION

A. Consult with Owner to review jobsite areas required for field offices, material storage and stockpiles, equipment storage, access to different locations, etc.

1.15 PERFORMANCE

A. Confine equipment, apparatus, and storage of material to work limits. The Owner will not be responsible for protection of materials and equipment from damage, pilfering, etc.

B. Install temporary facilities in such a manner that the installed work will not be damaged.

C. Do not use facilities of existing building unless authorized in writing by the Owner.

D. Effective September 1, 2012, OSU became a non-smoking campus and smoking is prohibited on all Campus property.

E. Keep facilities well maintained.

F. Relocate temporary facilities as required during job progress.

G. At Substantial Completion, clean and renovate permanent facilities that have been used during the construction period, including but not limited to:
   1. Replace air filters and clean inside of ductwork and housings.
   2. Replace significantly worn parts and parts that have been subject to unusual operating conditions.
   3. Replace lamps that are burned out or noticeably dimmed by substantial hours of use.

END OF SECTION

Oregon State University Construction and Maintenance Safety Requirements

EH&S, 130 Oak Creek Building, Corvallis, OR 97331-7405, (541) 737-2505, FAX (541) 737-9090

Complete OSU Construction and Maintenance Safety Form - Send completed documents (including Site Safety Plan and all separate answer pages) to Construction Contracts Administration along with the insurance and bonds.

Project Isolation - All construction and remodeling activities regardless of size and/or scope must be fenced, barricaded, or otherwise protected to restrict entrance and to ensure the safety of those in the general area. See isolation requirements.

Site Safety Plan - A site safety plan will be required and will address:

- General Information
- Emergency Information
- Key Organization Personnel
- Hazard Evaluation/Facility Impact
- Emergency Procedures
- Work Zones
- Security Measures
- Fire Protection

A model plan is attached. This form can be used if another plan has not already been prepared. Contact OSU Environmental Health & Safety for more information 737-2505.

Isolation Requirements

General: All construction, maintenance, and remodeling activities, regardless of size or scope, must be fenced, barricaded, or otherwise isolated to restrict entrance and to ensure the safety of those in the general area.

Outdoor Activities: Outdoor projects require the following perimeter isolation:

- A six foot chain-link fence, with controlled access points, extending in all directions around the excavation or building site such that no area of the construction is accessible to pedestrians or unauthorized personnel or vehicles.
- Isolation area will include vehicle loading and unloading areas.
- At the University's option, other barricading plans may be accepted. These may apply to projects such as road resurfacing, parking lot striping, exterior building water proofing, deliveries, etc. Contact EH&S regarding other barricading plans.

Overnight: Any excavation across or adjacent to sidewalks or pathways which must be left open overnight, must be identified with working, blinking construction lights in addition to solid barricades

Indoor Activities: Indoor construction or maintenance projects which will create dust, potentially hazardous fumes or vapors, or offensive odors are subject to the following isolation:

- Areas where existing doors can provide isolation will be labeled "Construction Area-- Authorized Personnel Only ".

- All other areas will be isolated by a solid barrier. The minimum barrier allowed is 4 mil poly sheeting sealed to prevent migration of dust.
- Mechanical ventilation may be required.
- A solid wall is required if building envelope is opened to the outside.

Contractor Responsibilities

- The contractor will provide all barricading, isolation, and fencing material. OSU will not provide any materials.
- The contractor will also provide all appropriate warning and detour signs when sidewalks, exits, or roads are closed.
- Contractor will provide all other construction area signs.

OSU Construction and Maintenance Safety Form

Send completed safety documents to Construction Contracts Administration with insurance and bonds.

Date: _____ Project: _____

Start Date: _____ Completion date: _____

Contractor: _____ Contact: _____

Work # _____ 24 hr #: _____

OSU Project Mgr: _____ Work / 24hr #'s: _____

Dept Contact: _____ OSU EH&S Contact: _____

Preconstruction meeting? **Y N** Date/Time/Location: _____

For the following items, prepare answers on a separate sheet for all items marked "Yes". Precede each answer with the appropriate item number. All boxes need to be checked

Y	N		For This Project	If YES, then:
		1	Will any confined spaces be accessed?	Describe location of entry Specify location of permit Notify EH&S prior to entry See SAF 209
		2	Will hot work be performed (welding, cutting, brazing, etc.)?	Provide min. 5# 2A10BC extinguisher within 10 ft If indoors - provide and describe ventilation See SAF 214
		3	Any products brought to campus?	Provide MSDS on site prior to first use; Make available to OSU on request
		4	Will lead paint be impacted?	Describe plan to limit contamination
		5	Will asbestos-containing-material be impacted?	Coordinate with OSU asbestos manager
		6	Will <u>any</u> materials (construction debris, soil, water, etc) be removed from campus?	Describe in detail identity and disposition of material (how, where)
		7	Any open trenches or holes?	Describe isolation procedures (see Page 1)
		8	Will a crane be used?	Describe crane safety plan (include plan to prevent loads above occupied areas)
		9	Is this project building a new facility, a major remodel?	Provide Site Safety plan Describe isolation procedures (see Page 1)
		10	Is this a minor remodeling project?	Provide, or fill out model Site Safety Plan form (see Page 3) Describe isolation procedures (see Page 1)
		11	Will air contamination be produced (e.g. dust, CO, solvent vapors, VOCs, odors)?	Describe project ventilation and isolation Indicate position of building air intake(s)
		12	Will there be noise > 85 dB?	Describe noise minimization plan
		13	Will this project use a scaffold or an external chute?	Describe isolation, dust control, installation
		14	Will this project involve a working surface >6' above a lower level	Describe fall protection
		15	Will any "blind" saw-cuts or penetrations be made in existing foundations, floors, ceilings and/or walls?	Describe plan for detecting and protecting power lines or other building utility lines.

EH&S Review: _____ Date: _____

Model Site Safety Plan

1. General Information

Contractor name _____
Address _____
City, State, Zip _____
Site Safety Officer _____ Project Dates _____
Project Name _____

2. Emergency Information

Emergency Response	911	OSU EH&S and OSU Facilities Services must be notified in the event of an emergency
Hazardous Materials Spill		
MSDS on-site location		
OSU EH&S	(541) 737-2505	
Facilities Services	(541) 737-2969	

3. Contractor Key Personnel

	Name	Phone	Emergency Contact
Company Owner			
Project Manager			
Job Supervisor			
Site Safety Officer			
Other Responsible Individual			
24 Hour Notification			

List of employees on site _____

_____

_____

4. Hazard Evaluation/ Facility Impact	
Physical	**Yes / No**
Heavy Equipment	
Noise	
Heat	
Elevation	
Radiation Materials	
Excavations	
Underground Utilities	
Confined Spaces	
Fire Prevention	
Electrical	

5. Emergencies
Services
Evacuation Route
First Aid Location
Hazardous Materials Spill Procedure

6. Work Zones

Material Storage _____
Parking locations _____
Individuals with OSU keys _____
Access issues _____

7. Security measures _____

_____

_____

8. Fire protection _____

_____

SECTION 01 56 39

TREE AND PLANTING PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section includes temporary fencing, barricades, and guards to protect trees, plants and groundcovers not indicated to be removed, as necessary and required to prevent damage above and below grade.

1.02 DEFINITIONS

A. Dripline: Outer perimeter of branches of any tree or plant.

B. Groundcover: Includes but not limited to plants and grass.

1.03 PERFORMANCE REQUIREMENTS

A. The Contractor shall exercise utmost care to protect existing trees and plants designated to remain and shall comply with all protection requirements provided by Owner and City of Corvallis as conveyed through the Owner's Authorized Representative.

B. The Contractor shall install tree protection fencing as detailed and shall prevent damage to shrubs, groundcover, trees, root systems, soil, bark, foliage, branches and limbs due to construction activities, including but not limited to:
   1. Soil contamination, erosion, and compaction.
   2. Excessive wetting, and ponding due to storm water, and construction run-off.
   3. Alteration of grade, stockpiling of soil, debris, and materials.
   4. Damage to soil, roots, bark, trunk, limbs, branches, and foliage.
   5. Prevent unauthorized cutting, breaking, skinning and bruising of roots, branches, and bark.

1.04 SUBMITTALS

A. Procedural proposal for tree and plant protection, describe methods of protection, and stabilization, provide drawings and supporting documentation as directed.

B. Contractor's Condition Inspection; include written report and color photographs.

1.05 PROJECT CONDITIONS

A. Install protection during initial mobilization at the Work site, and maintain until substantial completion.

B. If, in the opinion of the Owner's arborist, additional protection is required, the Contractor shall install additional fencing as directed and without cost to the Owner.

C. The location and requirements for additional fencing shall be determined by the

Owner's arborist prior to, and at any time during the course of the Work.

D. Fencing:
   1. Fencing shall be installed at the tree and plant protection areas as detailed on Plans, or as directed by the Owner's Authorized Representative.
   2. Tree and plant protection fences shall remain in place until all Work is completed and shall not be removed or relocated without the approval of the Owner's Authorized Representative.

E. Driving and Parking:
   1. Not permitted off paved surfaces without the approval of the Owner's Authorized Representative.
   2. When approved, the Contractor shall place plywood of sufficient thickness and width to support vehicles and prevent rutting on the area to be driven on.
   3. Care shall also be taken with respect to existing lawn sprinkler systems.

F. Storage of materials and Debris: Not permitted off paved surfaces.

PART 2 PRODUCTS

2.01 MANUFACTURED COMPONENTS

A. Chain Link Fencing: 11 gage galvanized chain link, six feet. tall, and 1.5 inch inside diameter galvanized steel line posts and 2.5 inch inside diameter corner posts, provide lockable gates as necessary.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Inspect trees, plants, and groundcovers, document existing conditions prior to installation of protection.

3.02 EXECUTION

A. Pruning and Cutting of Roots, Branches and Foliage:
   1. Review conditions with Architect or Owner prior to need for work, and proceed as directed.
   2. All pruning to be done by Owner's landscape maintenance personnel or ISA Certified arborist under the direction of Owner's Landscape Management Department.

   3. Perform pruning and cutting with sharp instruments intended for the purpose; do not break or chop.

B. Root Cuttings:
   1. Carefully and cleanly cut roots and branches of trees indicated to be left standing where such roots and branches obstruct new construction.

2. Protect exposed roots with wet burlap until they can be covered with soil.

C. Excavation and Trenching Within Drip Lines:
   1. Permitted where indicated, and at other specifically approved locations.
   2. Tunnel under or around roots by hand digging or boring.
   3. Do not cut main lateral roots and tap roots over one inch diameter; cut smaller roots which interfere with installation of new Work.
   4. Do not allow exposed roots to dry out before permanent backfill is placed; provide temporary earth cover, or pack with peat moss and wrap with burlap.
   5. Water and maintain roots in moist condition and temporarily support and protect from damage until permanently relocated and covered with backfill.

D. Existing Grading: Maintain within drip line of trees and plants unless otherwise indicated on the drawing and approved by the Owner's Authorized Representative.

E. Tree Protection:
   1. Provide temporary fence complying with Section 01 51 00 for protection of trees to remain.
   2. Extend fencing ten feet beyond dripline, except where greater distance is required for protection of Elm trees.
   3. Prevent entry into protected areas except as authorized in writing by the Owner's Authorized Representative.

3.03 REPAIR AND REPLACEMENT OF TREES AND PLANTS

A. Repair trees or shrubs damaged by construction operations as directed by the Owner.

B. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.

C. Damaged Trees, Shrubs and Groundcover:
   1. Replace where Owner's Authorized Representative determines restoration to normal growth pattern is not possible; plant and maintain as directed.
   2. Replacement trees up to 13 inches caliper and shrubs up to 4 feet tall: Same size as damaged tree or shrub, species selected by the Owner's Authorized Representative.
   3. Trees over 13 inch caliper and shrubs greater than 4 feet tall: Compensate Owner as determined by an acceptable consulting arborist registered with the American Society of Consulting Arborists.
   4. Replacement groundcovers: Same size and quality as damaged species selected by Owner's Authorized Representative.

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Summary:
   1. Product options.
   2. Owner-furnished products.
   3. Product delivery, storage and handling.

1.02 PRODUCTS

A. Products:
   1. New material, machinery, components, equipment, fixtures, and systems forming the Work, but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work.
   2. Products may also include existing materials or components specifically identified for reuse.

B. Use interchangeable components of the same manufacture for similar components.

C. Unless otherwise specified, all material and equipment shall be new; free from defects impairing strength, durability, and appearance; of current manufacture.

D. Items specified shall be considered minimum as to quality, function, capacity, and suitability for application intended.

E. Items incorporated into the Work shall conform to applicable specifications and standards designated, and shall be of size, make, type, and quality specified.

F. Design, fabricate, and assemble in accordance with current best engineering, industry, and shop practices.

G. Manufacture like parts of duplicate units to standard size and gauge to make them interchangeable.

H. Two or more items of the same kind shall be identical and made by the same manufacturer.

1.03 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 with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

C. Products Specified by Naming One [or More] Manufacturer[s]: Products of manufacturer[s] named and meeting specifications, no options or substitutions

allowed.

D. Substitution Procedure: Under Section 01 25 00.

1.04 REUSE OF EXISTING PRODUCTS

A. Except as specifically indicated or specified, materials and equipment removed from existing construction shall not be used in the completed Work.

B. For material and equipment specifically indicated or specified to be reused in the Work:
   1. Use care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
   2. Arrange for transportation, storage, and handling of products which require off-site storage, restoration, or renovation.
   3. Remove and reinstall mechanical units, vents, guys, antennae, and electrical and grounding wires or conduits.

1.05 OWNER FURNISHED PRODUCTS

A. Designate delivery dates of Owner-furnished items in the construction schedule.

B. Receive, unload, store and handle Owner-furnished items at the site; protect from damage.

1.06 DELIVERY, STORAGE AND HANDLING

A. Transport, handle, store and protect products in accordance with manufacturer's instructions.

B. Arrange deliveries in accordance with construction schedules; coordinate to avoid conflict with Work and site conditions.

C. Deliver and store products in undamaged condition in manufacturer's original containers or packaging with identifying labels intact and legible.

D. Inspect shipments to assure compliance with Contract Documents and reviewed submittals, and that products are undamaged.

E. Prevent soiling or damage to products or packaging.

F. Interior Storage: Maintain required temperature and humidity ranges. Verify that Owner furnished storage meets product manufacturer's requirements.

G. Exterior Storage:
   1. Store materials above ground to prevent soiling and/or moisture infiltration.
   2. Cover materials with waterproof breathable sheet coverings; provide adequate ventilation.
   3. All storage locations to be approved in advance by the Owner.

H. Arrange storage to provide access for inspection.

I. Coordinate with Owner’s Authorized Representative all on-site storage activities.

J. Provide for security of stored products.

END OF SECTION

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements and limitations for cutting and patching of Work.

1.02 RELATED SECTIONS

A. Section 01 25 00, Product Substitution Procedures.

B. Section 01 33 23, Shop Drawings, Product Data, Samples

1.03 SUBMITTALS

A. Submit written request in advance of cutting or alteration which affects:
   1. Structural integrity of any element of the Work.
   2. Efficiency, maintenance, or safety of any operational element.
   3. Visual qualities of sight exposed elements.
   4. Work of Owner or separate contractor.

B. Include in request:
   1. Identification of project.
   2. Location and description of affected work.
   3. Necessity for cutting or alteration.
   4. Description of proposed work, and products to be used.
   5. Alternatives to cutting and patching.
   6. Effect on work of Owner or separate contractor.
   7. Written permission of affected separate contractor.
   8. Date and time work will be executed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Primary Products: Those required for original installation.

B. Product Substitution: For any proposed change in materials, submit request for substitution under provisions of Section 01 25 00.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.

B. After uncovering existing work, inspect conditions affecting performance of Work.

C. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Provide temporary supports to ensure structural integrity of the Work.

B. Provide devices and methods to protect other portions of the Work from damage.

C. Provide protection from elements for areas which may be exposed by uncovering work.

3.03 CUTTING AND PATCHING

A. Execute cutting, fitting and patching to complete work.

B. Fit products together, to integrate with other work.

C. Remove and replace defective or non-conforming work.

D. Provide openings in the work for penetration of mechanical and electrical work.

3.04 PERFORMANCE

A. Execute work by methods to avoid damage to other Work, and which will provide appropriate surfaces to receive patching and finishing.

B. Cut rigid materials using masonry saw or core drill. Pneumatic tools are not allowed without prior approval from Owner's Authorized Representative.

C. Restore work with new products in accordance with requirements of Contract Documents.

D. At penetrations of fire rated walls, partitions, ceiling or floor construction, completely seal voids with approved fire rated material, to full thickness of the penetrated element.

E. Refinishing:
   1. Refinish surfaces to match adjacent finish.
   2. For continuous surfaces, refinish to nearest intersection or natural break.
   3. For an assembly, refinish entire unit.

END OF SECTION

SECTION 01 74 00

CLEANING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Related requirements specified elsewhere, cleaning for specific products or work: Specification section for that work.

B. Maintain premises and public properties free from accumulations of waste, debris, and rubbish, caused by operations.

C. At completion of Work remove waste materials, rubbish, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces; leave project clean and ready for occupancy.

1.02 QUALITY ASSURANCE

A. Standards: Maintain project in accord with applicable safety and insurance standards.

B. Hazard Control:
   1. Store volatile wastes in covered metal containers.
   2. Provide adequate ventilation during use of volatile or noxious substances.

1.03 MATERIALS

A. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

1.04 DURING CONSTRUCTION:

A. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

B. At reasonable intervals during progress of Work clean site and public properties, and dispose of waste materials, debris and rubbish.

C. Provide on-site containers for collection of waste materials, debris and rubbish.

D. Remove waste materials, debris and rubbish from site and legally dispose of at public or private dumping areas off Owner's property.

E. Vacuum clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis until project is ready for Substantial Completion or occupancy.

F. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.

1.05 FINAL CLEANING

A. Employ experienced workers, or professional cleaners, for final cleaning.

B. In preparation for Substantial Completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

C. Remove grease, dust, dirt, stains, labels, and other foreign materials from exposed interior and exterior finished surfaces.

D. Remove putty, paint, labels, lubricants, etc., from windows, mirrors, and sash, and then polish, taking care not to scratch glass.

E. Vacuum carpeting (shampoo where required), removing debris and excess nap.

F. Repair, patch and touch up marred surfaces to specified finish, to match adjacent surfaces.

G. Replace air filters where units were operated during construction.

H. Maintain cleaning until project, or portion thereof, is occupied by Owner.

END OF SECTION

SECTION 01 77 00

CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 DESCRIPTION

A. The requirements specified in this section relate to all Contractors individually performing under these Contract Documents:
   1. Project Record Documents.
   2. Final review and payment.

B. Related work specified elsewhere:
   1. OSU General Conditions.
   2. Shop Drawings, Product Data and Samples, Section 01 33 23.

1.02 PROJECT RECORD DOCUMENTS

A. The Project Record Documents shall be organized to include the following information:
   1. Table of Contents
   2. Project Team List
   3. Specifications (Including Addenda and Change Orders)
   4. Drawings
   5. Inspection Reports, as applicable
   6. Original Signed Warranty(ies)
   7. Maintenance Instructions

B. Draft Project Record Documents shall be submitted for review upon 75% completion of the Work.

C. Project Record Documents shall be submitted electronically to the Owner. Hard copies will not be accepted.

D. The project team list shall include the name, address, and phone number of the Owner, Contractor, Inspector, Subcontractors, and the materials manufacturers.

E. Legibly mark each Specification section to indicate actual as-built condition indicating changes in the Work made by addenda or change order or actual materials used and actual manufacturer(s) used.

F. Maintain current and accurate as-built mark-ups during construction and make available to Owner’s Authorized Representative upon request.

G. Legibly mark the drawings to indicate actual as-built conditions indicating changes in the Work made by addenda or change order or actual conditions which differ from the drawings.

H. Redraw or provide new drawings as required for a complete as-built set of drawings. The Contractor shall maintain current and accurate as-built mark-ups during construction and make available to Owner’s Authorized Representative.

I. Include inspection reports if applicable.

J. Include, in a single section, all copies of the Project's labor and material warranties clearly marked to identify the Owner's responsibilities under the terms of each warranty and the section of Work that each warranty covers. One set must be clearly marked as containing original documents.

K. In the case of an elevator installation, the Contractor's and manufacturer's warranty shall provide for the Owner's right to respond to emergency/car failure situations for the purpose of extricating individuals trapped in the elevator.

L. Include maintenance instructions complete with technical information and name, address, and phone number of the Contractor(s) and manufacturer(s) of each material and product.

1.03 FINAL REVIEW AND PAYMENT

A. Prior to completion, the Contractor shall inspect the Work and make a Punch-list noting all items that are incomplete and/or incorrect.

B. The Contractor shall notify all Subcontractors in writing of incomplete and/or incorrect items. Notify far enough in advance of the completion date that the Work can be completed on schedule. Said Work shall be immediately corrected.

C. Should conditions prevail which prohibit some elements of the Work from being accomplished, but the work-in-place will perform the primary function (i.e., painting cannot be completed due to high moisture content of masonry walls.) the Contractor shall record the reason with this Punch-list item requesting temporary delay in completion from the Owner in writing.

D. Notify the Owner in writing that all items are completed and ready for final review or else that the Work product is fully usable, but some listed deficiencies remain to be completed. Submit all record documents at this time.

E. The Owner will review all documents. When the documents include a Contractor's request for delay in completion, the Owner will review all Work which is certified as complete to the best knowledge of the Contractor. The Owner will also review the listed incomplete Work and assign a value to such uncompleted work.

F. The Contractor shall make the required corrections to the Work expeditiously. A letter will be addressed to the Contractor informing the Contractor of the project status.

G. When Contract closeout procedures are completed and all Punch-list deficiencies have been corrected, provide Owner with final corrected Project Record Documents based on Owner's preliminary review. Correct Project Record Documents shall be in electronic format.

H. Final Completion by the Owner will be documented and the Contractor will receive written notice of acceptance of the Work and notification that final

payment may be billed and released.

I. All warranties shall commence and become effective beginning on the date of Substantial Completion.

END OF SECTION

SECTION 02 41 00

DEMOLITION AND SALVAGE

PART 1 - GENERAL

1.01 DEMOLITION

A. Perform demolition work required for completion of new work, as shown on drawings, and as specified herein. Demolition plans and specifications generally show the extent of demolition required. They do not relieve contractor of responsibility for all demolition required to complete the work under this Contract.

B. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, all hangers including the top connection and any fastenings to building structural systems, line voltage and low voltage power, signal, or control wiring. Seal all openings after removal of equipment, pipes, ducts, raceway, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity and fire rating of the building system shall be maintained.

C. Perform only that demolition work necessary and required for completion of new work.

D. All demolition work other than minor work to be reviewed with and approved by Owner prior to starting.

E. In addition to demolition shown, cut, move or remove items as necessary to provide access, to allow alterations and new work to proceed, or items that are abandoned and serve no useful purpose. Include such items as:
   1. Repair or removal of hazardous or unsanitary conditions.
   2. Removal of unsuitable or extraneous materials not marked for salvage, and debris such as rotted wood, rusted metals, and deteriorated concrete.
   3. Removal of abandoned items and items serving no useful purpose as a result of the work of this contract such as abandoned piping, conduit and wiring. Remove items back to active piping mains or junction boxes.

1.02 REMOVED MATERIAL

A. Salvage all pieces of equipment which are removed as a result of new work, and which are not intended for reuse to Owner unless specifically waived by Owner. If waived by Owner, equipment shall become the property of the Contractor and shall promptly be removed from the work site.
   1. All removed material not to be salvaged to the Owner or reused shall become property of the Contractor, and shall be promptly removed from site. Do not store or permit debris to accumulate on site.
   2. Care should be taken when removing salvaged equipment to avoid damage and to maintain equipment in an operational condition. Contractor is responsible and shall pay for all damages to salvaged equipment found to be non-operational after delivery to Owner.

B. Refrigerant Disposal: Contractor shall remove, transport, and dispose of refrigerant contained in existing systems in accordance with Authority Having Jurisdiction. Contractor shall provide copies of regulatory documentation to the Owner’s Authorized Representative.

1.03 COORDINATION WITH EXISTING TO REMAIN

A. When demolition work affects the support, access to, or operation of existing equipment or materials, Contractor shall provide new support, access means, and any other modifications necessary to maintain existing systems fully maintainable, operational, and in compliance with regulatory codes.

1.04 PROTECTION

A. Protect workers, passers-by, and neighboring property from injury and damage. Protect existing building services including roofing and flashing from damage. Protect access and egress in public areas. Provide temporary guardrails and barricades to assure safe access through adjacent areas of construction. Protect existing utilities and active services to all operating systems indicated or not.

PART 2 - PRODUCTS

2.01 THIS PART NOT USED

PART 3 - EXECUTION

3.01 THIS PART NOT USED

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Section includes:
1. Structural steel.
2. Reinforcing steel welded to structural steel.
3. Grout for base plates and bearing plates.

1.02 APPLICABLE STANDARDS (LATEST EDITIONS APPLY) UNLESS OTHERWISE NOTED.

A. ASTM – American Society for Testing and Materials
1. A6 – Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.
2. A36 – Specification for Steel.
3. A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
4. A123 – Specification for Zinc (Hot Dip Galvanized) Coating on Iron and Steel Products.
5. A153 – Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. A307 – Specification for Carbon Steel Externally Threaded Standard Fasteners.
7. A325 – Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.
8. A354 – Specification for Quenched and Tempered Steel Bolts and Studs and Other Externally Threaded Fasteners.
9. A449 – Specification for Quenched and Tempered Steel Bolts and Studs.
10. A490 – Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.
11. A500 – Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. A563 – Specification for Carbon and Alloy Steel Nuts, 1990 Edition.
13. A572 – Specification for High Strength Low Alloy Columbium-Vanadium Steel of Structural Quality.
14. A615 – Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
15. A706 – Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
16. A780 – Specification for Repair of Damaged Hot-Dip Galvanized Coatings.
17. A913 – Specification for High Strength Low Alloy Shapes of Structural Quality Produced by Quenching and Tempering Process.
18. A992 – Specification for Steel for Structural Shapes for use in Building Framing.
19. C1107 – Specifications for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
20. F844 – Specification for Washers, Steel, Plain (Flat) Unhardened for General Use.

B. AISC – American Institute of Steel Construction
1. Specification – Steel Construction Manual
2. Specification – ANSI/ AISC 360-05 Seismic Provisions for Structural Steel Buildings, 2005.
3. Code – Code of Standard Practice for Steel Buildings and Bridges, 2005 Edition. Articles 3.2 and 3.3 and Section 4 and 9 of AISC Code are superseded by requirements of the General Conditions, Special Conditions and Contract Documents.

C. AWS – American Welding Society
1. D1.1 – Structural Welding Code.
2. D1.4 – Structural Welding Code – Reinforcing Steel.

D. ICC – International Code Council:
   1. OSSC – Oregon Structural Specialty Code, 2014 Edition.

E. ASCE/ SEI – American Society of Civil Engineers:
   1. 07-05, Minimum Design Loads for Buildings and Other Structures

F. SSPC – Steel Structures Painting Council's, "Systems and Specifications".
   1. SP1 – Solvent Cleaning.
   2. SP2 – Hand Tool Cleaning.
   3. SP3 – Power Tool Cleaning.
   4. SP6 – Commercial Blast Cleaning.

1.03 DEFINITIONS

A. Architecturally Exposed Structural Steel (AESS).
   1. Structural steel framing exposed to view from the building exterior.
   2. Structural steel framing noted as AESS on Drawings.

B. Heavy Shapes: ASTM A6, Group 3 shapes with flanges thicker than 1 – ½-inches and Group 4 shapes and Group 5 shapes; welded built-up members with plates exceeding 2-inches in thickness.

C. Seismic Critical Weld:
   1. Complete penetration welds in beam to column connections, including flange, flange reinforcement, stiffener plate and doubler plate welds.
   2. Complete penetration welds of column splices and of columns to base plates.
   3. Other complete penetration welds indicated as "Seismic Critical" on Drawings.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Provisions of AISC Code, Section 4, are superseded by requirements of General Conditions, Special Conditions, and Section 01 33 00 of these specifications.
   2. Show size and location of structural members; give complete information necessary for the fabrication of members including cuts, copes, holes, stiffeners, camber, type and size of bolts and welds, surface preparation and finish; show methods of assembly.
   3. Indicate welded connections using standard AWS symbols and clearly distinguish between shop and field welds.
   4. Identify high strength bolted connections (snug-tight or slip-critical).

B. Certificates of compliance with specified standards.
   1. All steel.
   2. Fasteners, including nuts and washers.
   3. Welding electrodes.
   4. Studs.
   5. Non-shrink Grout.
   6. Reinforcing steel.
   7. Primer Paint.

C. Certified manufacturer's test reports: Submit to Testing Laboratory for record purposes.
   1. All Steel: Tensile tests and chemical analysis, welds. Include all trace elements for steel to receive Seismic Critical Welds.
   2. High Strength bolts: As per ASTM A325, Section 1.4; or A490, Section 1.6.
   3. Reinforcing Steel: Chemical, tensile and bend tests.
   4. Heavy Shapes: Charpy V-Notch

D. Product Data
   1. Welding Electrodes

E. Welder Certification

F. Written Welding Procedure Specification (WPS) in accordance with AWS D1.1 requirements for each different welded joint proposed for use, whether prequalified or qualified by testing.
   1. Indicate as-detailed configuration and also the maximum and minimum fit-up configurations.
   2. Identify specific electrode and manufacturer.
   3. List actual values of welding parameters to be used so that clear instruction is provided to welders.

G. Procedure Qualification Record (PQR) in accordance with AWS D1.1 for all procedures qualified by testing.

H. Samples: As requested by the Testing Laboratory.

1.05 QUALITY ASSURANCE

A. Code and Standards: Comply with provisions of following, except as otherwise indicated:
   1. AISC "Code of Standard Practice for Steel Buildings and Bridges", 2005 Edition. Articles 3.2 and 3.3 and Sections 4 and 9 of AISC Code are superseded by requirements of the General Conditions, Special Conditions and Contract Documents.
   2. AWS D1.1 "Structural Welding Code – Steel."
   3. ANSI/ AISC 360-05 Specifications for Structural Steel Buildings "Allowable Stress Design and Plastic Steel Design for Structural Steel Buildings."
   4. Research Council in Structural Connections – “Specifications for Structural Joints Using ASTM A325 or A490 Bolts”.

B. Qualifications for Welding Work: Qualify welding procedures and welding operators in accordance with AWS D1.1, "Qualification" requirements.
   1. Qualify welders in accordance with AWS D1.1 for each process, position and joint configuration.
   2. WPS's for each joint type shall indicate proper AWS qualification and be available where welding is being performed.
   3. Welders who have not performed the required welding procedure for a period of six or more months shall be requalified.
   4. Welders whose work fails to pass inspection shall be requalified before performing further welding.
   5. If recertification of welders is required, retesting will be Contractor's responsibility.

C. Field Measurement: Field verify all existing conditions affecting steel members and steel member placement prior to fabricating and installation of steel members.

D. Pre-Fabrication/Pre-Erection Conferences: Contractor shall schedule meeting with Structural Engineer, Testing Laboratory and the Steel Fabricator and Erector's personnel supervising shop and field welding to review welding procedures and inspection requirements for "Seismic Critical Welds."

E. Welding Inspector Qualifications: All welding inspectors shall be AWS certified welding inspectors (CWI) as defined in AWS Standard and Guide for Qualification and Certification of Welding Inspectors, latest edition. Welding inspector's qualifications shall be submitted to the Structural Engineer for approval. Inspectors shall be trained and thoroughly experienced in inspecting welding operations. Comply with AWS section 6.1.3.

1.06 SCHEDULING AND SEQUENCING

A. Ensure timely delivery of items to be embedded in work of other sections such as cast-in-place concrete; furnish setting drawings or templates and directions for installation.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General: All steel shall be identified as required by OSSC Section 2203.1.Steel which is not properly identified shall be tested to show conformance with requirements of applicable ASTM Standard at Contractor's expense.

B. Exposed Surfaces: For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness. Remove such blemishes by grinding or by welding and grinding, prior to cleaning, treating and applying surface finishes.

C. Steel W Shapes: ASTM A992
1. Heavy Shapes (see "Definitions" in this Section) shall be supplied with Charpy V-Notch testing in accordance with ASTM A6 Supplementary Requirement S5. The impact test shall meet a minimum average value of 20 ft-lbs absorbed energy at +70 degrees Fahrenheit and shall be conducted in accordance with ASTM A673, frequency H, with the following exceptions:
   a. The center longitudinal axis of the specimens shall be located as near as practical to midway between the inner flange surface and the center of the flange thickness at the intersection with the web mid-thickness.
   b. Tests shall be conducted by the producer on material selected from a location representing the top of each ingot or part of an ingot used to produce the product represented by these tests.

D. Steel Channels and Angles: ASTM A36; or dual certified ASTM A36/A572.

E. Steel Plates and Bars:
1. ASTM A572, Grade 50, unless indicated otherwise.
2. ASTM A36 where designated on Drawings.

F. Steel Pipes: ASTM A53, Type S, Grade B.

G. Steel Tubing: ASTM A500, Grade B.

H. Standard Threaded Fasteners: ASTM A307, Grade A, bolts with ASTM A563 hex nuts.

I. High Strength Bolts:
1. ASTM A325, type 1; unless indicated otherwise.
2. ASTM A490 where designated on Drawings.
3. Nuts and washers conforming to AISC Part 7.

J. Anchor Bolts (unless otherwise indicated on Drawings):
1. 1-inch diameter and small bolts: ASTM A307, Grade A.
2. Larger than 1-inch diameter bolts: ASTM A449.
3. Washers: ASTM F844; 5/16-inch minimum thickness.
4. Nuts: ASTM A563, heavy hex.

K. Anchor Bolts (where designated on Drawings):
1. ASTM A354, Grade BD, externally threaded rod; form head with ASTM F436 hardened washer between double ASTM A563, DH, heavy hex nuts.
2. Plate washer: ASTM F844; ½-inch minimum thickness.
3. Nuts: ASTM A563, Grade DH, heavy hex.

L. Welding Materials: AWS D1.1; type required for base metals being welded.
1. Electrodes shall be low hydrogen.
2. Electrodes for "Seismic Critical Welds" shall have a minimum Charpy V-notch toughness of 20 ft-lbs at –20 degrees Fahrenheit.

M. Shop Primer:
1. Type A Primer: Conforming to federal, state and local v.o.c. regulations; containing no lead or chromates; Tnemec Series FD88, or approved equal.
2. Type B Primer: Organic zinc-rich urethane; conforming to federal, state and local v.o.c. regulations; Class A coating, Tnemec "90-97 Tneme-Zinc", or approved equal.

N. Studs:
1. Headed Shear Connector Studs; AWS D1.1, Type B; as-welded size as shown on Drawings.
2. General Purpose Studs; AWS D1.1, Type A; as-welded size and configuration as shown on Drawings.

O. Reinforcing Steel: ASTM A706, deformed.

P. Non-shrink Grout: Premixed, nonmetallic, noncorrosive product, complying with ASTM C1107, Class B or C, at flowable consistency for 30 minutes for temperature extremes of 45 degrees F to 90 EF.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Euco N.S., Euclid Chemical Co.
   b. Masterflow 928, Master Builders.
   c. Five Star Grout, U.S. Grout Corp.
   d. Sika Grout 212, Sika Corp.

2.02 FABRICATION

A. Fabricate structural steel in accordance with AISC Specification and AISC Code.
1. Architecturally Exposed Structural Steel conform to Section 10 of AISC Code.
2. Fabricate joints in heavy shapes in accordance with additional requirements of Section A 3.1(c) of AISC Specification.

B. Connections: Where connection is not shown, design in accordance with standard practice unless otherwise directed by the Architect.

C. Drill, not punch, holes centered 6" or less from an edge to be complete penetration welded.

D. Assembly with High Strength Bolts
1. Construct connections in accordance with OSSC, Section 1704, using provisions for slip-critical joints, unless snug-tight bolts are indicated on Drawings.
2. Use standard holes, unless otherwise indicated on Drawings.

E. Assembly with Standard Threaded Fasteners
1. Draw up tight, check threads with chisel or provide approved lock washers or self-tightening nuts.
2. Provide beveled washers under bolt heads or nuts resting on surfaces exceeding five percent slope with respect to head or nut.

F. Welded Construction
1. Examine fit-up of joint for conformance with welding procedure specification. Do not proceed with welding until fit-up is inspected by Testing Laboratory.
2. Weld in accordance with AISC Specification using manual shielded arc method or flux cored arc method in accordance with AWS D1.1. Weld only in accordance with welding procedure specifications (WPS) for joint, which are to be available to welders and inspectors during the production process.
3. Groove welds shall be complete joint penetration welds, unless specifically designated otherwise on Drawings. Groove preparation is at Contractor's option, subject to qualification in accordance with AWS D1.1. Runoff plates shall be in accordance with AWS D1.1; end dams shall not be used.

4. Remove back-up plates for complete joint penetration wields where indicated in Contract Documents or when requested by Testing Laboratory to perform nondestructive testing. Remove at no additional cost to Owner.
5. Complete penetration groove weld Heavy Shapes in accordance with AISC Specification Section J1.7 for tension splices.
6. The following additional requirements apply to "Seismic Critical Welds":
   a. Use electrodes specified for Seismic Critical Welds.
   b. At beam flange to column welds, remove back-up plates, back gouge, clean by grinding and back weld with reinforcing fillet, unless Drawings specifically indicate that back-up bar may remain. Do not place reinforcing fillet until Testing Lab has inspected groove weld.
   c. Cut off runoff plates 1/8-inch from edges and grind smooth (not flush).
7. Weld reinforcing steel to structural steel in accordance with AWS D1.4 using prequalified procedures.
8. Grind exposed welds of Architecturally Exposed Structural Steel smooth and flush with adjacent finished surface.

G. Column Bases: Finish in accordance with AISC Specification. Lack of contact bearing with column shall not exceed 1/16 inch.

H. Bearing Plates: Provide for attached or unattached installation under beams, and girders resting on footings, piers, and walls.

I. Headed Studs: Automatically end weld in accordance with AWS D1.1 and manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and steel member.

2.03 FINISHES

A. Preparation of Surfaces
1. All surfaces shall be cleaned per SSPC-SP1 "Solvent Cleaning" to remove oil and grease prior to any other surface preparation.
2. After fabrication, prepare the following steel surfaces in accordance with SSPC-SP2 "Hand Tool Cleaning":
   a. Steelwork to be spray-fireproofed.
   b. Steelwork to be encased in concrete.
   c. Steelwork to be hot-dip galvanized.
3. Treat faying surfaces of slip-critical high strength bolted connections to achieve Class C surface in accordance with AISC 303-05.

2.04 SOURCE QUALITY CONTROL

A. The Testing Laboratory will:
1. Review manufacturer’s test reports for compliance with specified requirements.
2. Verify material identification.
3. Inspect high-strength bolted connections as required by OSSC Section 1704 for conformance with OSSC Chapter 22.
4. Inspect welding as required by OSSC Section 1704 in accordance with AWS D1.1. The following should be performed with each weld:
   a. Verify Welding Procedure Specification (WPS) sheet has been provided and has been reviewed with each welder performing the weld. Welds not executed in conformance with the WPS are rejectable.
   b. Verify fit-up meets tolerances of WPS and mark joint prior to welding.
   c. Verify welding consumables per Contract Documents and WPS.
   d. Verify welder qualification and identification.
   e. Verify amperage and voltage at the arc with hand-held meters.
   f. Observe preheat and interpass temperatures, weld pass sequence and size of weld bead.
5. For Seismic Critical Welds, inspect removal of back-up and run-off plates, preparatory grinding and execution of reinforcing fillet.

6. Nondestructive test all complete penetration groove welds larger than 5/16 inches by ultrasonic methods for conformance with the weld quality and standard of acceptance of AWS D1.1 for welds subject to tensile stress. Pass sound through the entire weld volume from two crossing directions to extent feasible.
7. Ultrasonically inspect base metal thicker than 1/2 inch for discontinuities behind welds in accordance with ICNO OSSC Section 1704.3.
8. Periodically, inspect and test stud welding as required by OSSC Section 1704 in accordance with AWS D1.1; except that test studs shall be subjected to a 90° bend test by striking them with a hammer. Review preproduction testing and qualification, periodically inspect welding and perform verification inspection and testing.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine existing structure to support construction and verify the following:
1. Location and elevation of bearings and anchor bolts are correct.
2. Other conditions adversely affecting erection of steel are absent.

B. Do not begin erection before unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Supervise setting of anchor bolts and other embedded items required for erection of structural steel. Be responsible for correct bearing of steel and correct location of anchor bolts.

3.03 ERECTION

A. Erect structural steel in accordance with AISC Specification and AISC Code.

B. Grouting Baseplates and Bearing Plates: Prior to erection, clean and roughen concrete surface beneath baseplate to full ¼" amplitude; clean bottom surface of baseplate of bond-reducing materials. After columns have been positions and plumbed, flow non-shrink grout solidly between bearing surfaces to ensure no voids remain. Comply with manufacturer's recommendations for mixing, placing, finishing and curing of grout.

C. Where erection requires performing work of fabrication on site, conform to applicable standards of Fabrication Article.

D. Field corrections of major members will not be permitted without the Architect's prior approval.

E. Gas Cutting: Use of flame cutting torch will be permitted only after the Architect's prior approval and only where metal cut will not carry stress during cutting, stresses will not be transmitted through flame-cut surface and cut surfaces will not be visible in finished work.
1. Make cuts smooth and regular in contour.
2. To determine effective width of members so cut, deduct 1/8-inch from least width at cut edge.
3. Make radius of cut fillet as large as practical, but in no case less than one inch.
4. Do not use flame cutting torch to align bolt holes.

F. Field Touch-Up Painting: After erection, touch-up or paint field connections and abrasions in shop paint with same paint used for shop painting. Touch up galvanized surfaces in accordance with ASTM A780.

3.04 CLEANING

A. After erection, thoroughly clean surfaces to foreign or deleterious matter such as dirt, mud, oil, or grease that would impair bonding of fire-retardant coating, paint or concrete.

3.05 FIELD QUALITY CONTROL

A. The Owner's Testing Laboratory will:

1. Inspect erected structural steel as required to establish conformity of Work with reviewed shop drawings and Contract Drawings.
2. Inspect high-strength bolted connections as required by OSSC Section 1704 for conformance with OSSC Chapter 22.
3. Inspect welding as required by OSSC Section 1704 in accordance with AWS D1.1. The following should be performed with each weld:
   a. Verify Welding Procedure Specification (WPS) sheet has been provided and has been reviewed with each welder performing the weld. Welds not executed in conformance with the WPS are rejectable.
   b. Verify fit-up meets tolerances of WPS and mark joint prior to welding.
   c. Verify welding consumables per Contract Documents and WPS.
   d. Verify welder qualification and identification.
   e. Verify amperage and voltage at the arc with hand-held meters.
   f. Observe preheat and interpass temperatures, weld pass sequence and size of weld bead.
4. For Seismic Critical Welds, inspect removal of back-up and run-off plates, preparatory grinding and execution of reinforcing fillet.
5. Nondestructive test all complete penetration groove welds larger than 5/16 inches by ultrasonic methods for conformance with the weld qualify and standard of acceptance of AWS D1.1 for welds subject to tensile stress. Pass sound through the entire weld volume from two crossing directions to extent feasible.
6. Periodically, inspect and test stud welding as required by OSSC Section 1704 in accordance with AWS D1.1; except that test studs shall be subjected to a 90° bend test by striking them with a hammer. Review preproduction testing and qualification, periodically inspect welding and perform verification inspection and testing.

END OF SECTION

SECTION 07 50 00

ROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Modification of existing roof system.

1.02 SUBMITTALS

A. Submit the following product information, shop drawings, and certifications in accordance with Section 01 33 23:
   1. Roofing manufacturer's applicable installation specifications and details.
   2. List of materials proposed for use.
   3. Certification that roofing contractor is authorized by roofing manufacturer to perform work as required to maintain existing warranty.

1.03 QUALITY ASSURANCE

A. Roofing contractor must be authorized by roofing manufacturer.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver material in original packages, manufacturer's original labels thereon. Do not remove labels or open packages until inspected by Owner's Authorized Representative.

B. Deliver materials to jobsite on pallets. Pallet label shall indicate material name, production date and/or product code.

C. Store materials in dry, protected areas in an upright position. Control temperature of storage areas in accordance with manufacturer's instructions. Protect materials from freezing.

1.05 ENVIRONMENT REQUIREMENTS

A. Do not apply roofing unless correct system application temperatures can be maintained to obtain good adhesion. Operation shall not be conducted when water in any form is present on deck, such as rain, dew, ice, frost, or snow.

1.06 WARRANTY

A. Existing roofing system is under warranty. Roofing Contractor shall modify roofing to perform Work of this agreement in conformance with all the manufacturer's warranty requirements to maintain the existing warranty in full effect. The Roofing Contractor shall be responsible for proper placement of metalwork which has been provided by other trades and is in contact with roofing.

B. Contractor shall provide a written labor and material warranty guaranteeing all modifications to the roofing and flashing systems performed as a part of this project's Work shall be weathertight for a period of two (2) years following final acceptance of the project.

PART 2 - PRODUCTS

2.01 ROOFING SYSTEMS

A. The existing roofing system is a Firestone EPDM membrane and ballast roof system installed over roof insulation. All modifications shall be compatible systems by the original roofing system manufacturer and shall be visually compatible with the existing roof system color.

B. Equipment curbs
1. Install new membrane to full height of curb and 10-12” past seam. Add outside reinforcement at all corners. Match existing membrane thickness. All EPDM roof seams to use thermoset seam tape. Use membrane cleaner prior to membrane and seam tape attachment. Use manufacturer recommended edge lap sealant on all exposed edges.

2.02 AUXILARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
1. Liquid type materials shall comply with VOC limits for authorities having jurisdiction.

B. Sheet Flashing: 60 mil thick EPDM, partially cured or cured, according to application.

C. Bonding Adhesive: Manufacturer’s standard.

D. Seaming Material: Manufacturer’s standard, synthetic rubber polymer primer and 3-inch-wide minimum, butyl splice tape with release film.

E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

F. Miscellaneous Accessories: Provide lap sealant, water cutoff mastic, metal termination bars, metal battens, pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, walking pads, and other accessories.

2.03 OTHER MATERIALS

A. Manufactured or recommended by firm listed above and recommended by manufacturer for conditions of installation.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor and Owner shall perform a joint inspection of existing roof conditions prior to start of construction. Contactor shall photo document existing roofing defects and submit documentation to Owner’s Authorized Representative. Beginning of work shall constitute acceptance of existing roof conditions.

B. Do not proceed until surfaces to receive roofing are smooth, sound, clean, dry and free of defects. Do not start Work until conditions are satisfactory.

C. Roof deck must be structurally sound. Areas showing a loss of integrity shall be repaired or replaced prior to the installation of the roofing system.

3.02 PREPARATION

A. Remove trash, debris, grease, oil, water, moisture, and contaminants which may affect bond of asphalt deck surface.

B. Prepare surfaces according to manufacturer's published instructions.

C. Use cleaning materials necessary to render an acceptable surface.

D. Use compatible materials on voids and joints so finished deck surface will be uniform.

E. Incomplete membrane edges and flashings shall be protected against water entry so that they will remain watertight for an extended period if inclement weather occurs.

F. Damage components must be repaired or replaced if building damage occurs during construction.

3.03 PROTECTION

A. Protect against damage and discoloration caused by Work of this section. Prevent debris from entering and clogging roof drains and gutters.

B. Protect existing roof membrane during construction from damage resulting from construction activities of all trades. Protect adjacent areas from damage with tarpaulin or other durable material.

C. Protection shall be utilized at all hoisting points to protect building walls.

D. Provide protection at traffic and walkway areas to protect access to existing buildings.

3.04 INSTALLATION

A. Comply with all of the manufacturer's installation recommendations. Pay particular attention to any recommendations relating to patching of aged roofing systems.

B. Plans and specifications show minimum requirements. Work shall conform to manufacturer's recommendations and installation instructions. Notify Owner's Authorized Representative if conflict exists between Construction Documents and manufacturer's instructions.

C. Walking Treads: Provide new walking treads between access points and new roof mounted equipment as required, and as shown on Drawings.

3.05 CLEANING

A. Include Work of other sections, clean, repair and touch-up, or replace where directed, products which have been soiled, discolored, or damaged by Work of this section. Remove debris from project site at Work completion or sooner, if directed.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
   1. Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1.02 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.03 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Preconstruction field test reports.

D. Compatibility and adhesion test reports.

E. Product test reports.

1.04 QUALITY ASSURANCE

A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

B. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates according to the method in ASTM C 1193 that is appropriate for the types of Project joints.

1.05 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Owner and Engineer from manufacturer's full range.

2.03 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Low Modulus, fast curing, nonsag, silyl-terminated polyether (STPe):
1. Products:
   a. BASF, Sonneborn Products; Sonolastic 150 with VLM Technology.
2. NS (nonsag).
3. Uses Related to Exposure: NT (nontraffic).
4. Uses related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

D. Interior Joint Caulking, Single-Component Neutral- and Basic-Curing Silicone Sealant:
1. Products:
   a. Dow Corning Corporation; 799.
   b. Tremco; Spectrem 2.
   c. GE Silicones; SilPruf SCS2000.
   d. Sonneborn, Division of ChemRex Inc.; Omniseal.
   e. Pecora Corporation; 895.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 50.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: O.
6. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C 1248.

2.04 LATEX JOINT SEALANTS

A. Latex Sealant Caulk: Comply with ASTM C 834, Type O P, Grade NF.

B. Products:
1. Pecora Corporation; AC-20+.
2. Sonneborn, Division of ChemRex Inc.; Sonolac.
3. Tremco; Tremflex 834.

2.05 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

2.06 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants.
1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant.
   a. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.02 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

C. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

D. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

E. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION

SECTION 22 05 00

GENERAL PLUMBING PROVISIONS

PART 1 - GENERAL

1.01 CONTRACT DOCUMENTS

A. General plumbing provisions apply to all work performed in Division 22.

B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.

C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.

D. Particular attention is called to Instructions to Bidders, General Conditions, Drawings and Specifications, and modifications incorporated in the documents before execution of the Agreement.

E. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.

F. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

1.02 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): The governmental agency or sub-agency which regulates the construction process.

B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

1.03 COORDINATION

A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before start of work.

B. Coordinate identification systems with other trades. All plumbing and mechanical systems shall use identical piping, valve, and equipment identification and regulatory signage.

1.04 SUBMITTALS AND SHOP DRAWINGS

A. General Requirements:
   1. All submittals shall be provided electronically.
   2. The Owner's Authorized Representative will be identified during the pre-construction conference. Deliver all submittals electronically in PDF format to Engineer and Owner's Authorized Representative using one of the following means:
      a. Send to e-mail address or FTP site provided at pre-construction conference.
      b. Send through online review format utilizing "Bluebeam Studio" to complete transmittal and review process.

B. Electronic Submittals: Transmit each item with approved transmittal form referencing the project, the Owner, and the Contractor. Identify and incorporate information in each electronic submittal file as follows:
   1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of each single Specification Section and transmittal form with links enabling navigation to each item. Include Division and section bookmarks in PDF files.
   2. Name file with submittal number or other unique identifier, including revision identifier.
      a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
   3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer and Owner's Authorized Representative.
   4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software or electronic form acceptable to Owner, containing the following information:
      a. Project name.
      b. Date.
      c. Name and address of Engineer.
      d. Name of Construction Manager.
      e. Name of Contractor.
      f. Name of firm or entity that prepared submittal.
      g. Names of subcontractor, manufacturer, and supplier.
      h. Category and type of submittal.
      i. Submittal purpose and description.
      j. Specification Section number and title.
      k. Specification paragraph number or drawing designation and generic name for each of multiple items.
      l. Drawing number and detail references, as appropriate.
      m. Location(s) where product is to be installed, as appropriate.
      n. Related physical samples submitted directly.
      o. Indication of full or partial submittal.
      p. Transmittal number, numbered consecutively.
      q. Submittal and transmittal distribution record.
      r. Other necessary identification.
      s. Remarks.

C. Action Submittal Content
   1. Action submittal information not expressly required by the specifications will not be reviewed.
   2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
   3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
   4. Action submittal requirements will be listed in individual specification sections. The following definitions apply.
      a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
      b. Catalog data: Manufacturer's standard product cut sheet.
      c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.

d. Performance Data: Capacity, input, output, flow, etc as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
e. Wiring Diagrams: Power and control wiring diagrams.
f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
g. Installation Instructions
h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

1.05 QUALITY ASSURANCE

A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.

B. Asbestos products or equipment or materials containing asbestos shall not be used.

1.06 DESIGN REQUIREMENTS

A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.

B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

1.07 CODES AND STANDARDS

A. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.

B. Work shall comply with the Americans with Disabilities Act (ADA).

1.08 TEMPORARY SERVICES

A. Provide in accordance with Section 01 50 00 "Temporary Facilities and Controls" as required for completion of work. Provide additional filters as required to keep areas clean during construction

B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

1.09 OPERATIONS AND MAINTENANCE MANUALS

A. Provide draft Operation and Maintenance Manual for review.

B. Bind manuals in three-ring, high quality vinyl covered binders, clearly indexed and provided with thumb tabs for each item or product. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each. Index tabs shall match submittal schedule and include any additional information required for operations and maintenance, whether in submitted schedule or not.

C. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.

D. Provide copy of approved submittal for each product included in manual

E. Provide printed copy and electronic configuration files for all packaged equipment control systems furnished with equipment.

F. Mark the model actually provided where the literature covers more than one model. Include four copies of all submittal data corrected to "as-built" conditions within the manual.

G. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.

H. Manual Content: Manuals shall contain complete information for each item of plumbing electrical or other operating equipment. Include as applicable:
1. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance
2. Lubrication schedules
3. Performance capacity
4. Catalog data sheets
5. Parts list
6. Maintenance schedules

1.10 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Transfer all information to one hard copy of drawings at completion of project. Alternately, provide electronically using .pdf markup of contract drawings.

1.11 DEMONSTRATION

A. General: After installation is complete, demonstrate to Engineer and Owner’s Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.

B. Preparation: Prior to demonstration, submit check-off list indicating completeness of submittals and certificates of compliance for review to Owner’s Authorized Representative. Operate completed system for one week. Verify that control verification is complete and verification report has been approved by Architect/Engineer.

C. Arrange for demonstration with Owner, Engineer, required factory technicians, and installer at least one week in advance of demonstration.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS

A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.

B. Equipment used as the basis of design is scheduled on drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated plumbing and electrical systems needed to provide equal system performance and maintainability.

PART 3 - EXECUTION

3.01 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights, electrical outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

C. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner’s Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Architect/Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

3.02 CLEANING SYSTEMS

A. General: After all equipment and pipes are installed, system shall be thoroughly cleaned. Remove all stickers and tags from equipment or fixtures. Clean all piping systems prior to installation of insulation or painting.

3.03 START UP

A. The Plumbing Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes hangers and supports for plumbing piping and equipment

1.02 DEFINITIONS

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

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Supports for multiple pipes, including pipe stands, shall be capable of supporting combined weight of supported systems, system contents, and test water.
   2. Equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.04 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 22 05 00 – General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:
   1. Materials List
   2. Catalog Data
   3. Detailed Data
   4. Performance Data
   5. Wiring Diagrams
   6. Shop Drawings
   7. Installation Instructions
   8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe Hangers and Supports		X						
Thermal Hanger Shield Inserts		X						

1.05 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.01 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: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. B-line, an Eaton business.
b. Thomas & Betts Corporation; A Member of the ABB Group.
c. Unistrut; Part of Atkore International.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.

2.03 INSULATION INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. National Pipe Hanger Corporation.
2. Pipe Shields Inc.
3. Insulshield
4. Uni-Grip

B. General: Insulation insert for use with MSS Type 40 protection saddle.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.06 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

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. Piping Operating Above Ambient Air Temperature:
   a. All Other Piping: Provide Insulation Insert with MSS Type 40 protection shield.
2. Piping Operating Below Ambient Air Temperature:
   a. Provide Insulation Insert with MSS Type 40 protection shield.
3. 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.
4. Insulation Inserts: Same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

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

B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 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.

3.04 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.

3.05 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 A 780.

3.06 HANGER SPACING

A.

PLUMBING PIPING SPACING TABLE	Maximum Horizontal Span	Maximum Vertical Spacing
Copper Tubing		
¾ inch and smaller	5 feet	10
Cast Iron		
All sizes	5 feet except where 10 feet where 10 foot lengths are installed.	

3.07 ROD SIZES

A. Select rod diameter to not exceed the maximum safe load listed in Table 2 of MSS SP-58-2009.

3.08 HANGER AND SUPPORT SCHEDULE

A. Single Pipe, Hung and Uninsulated
   1. NPS ½ to NPS 3: Adjustable Steel Band Hanger, MSS Type 7.

B. Single Pipe, Hung and Insulated
   1. Operating Temperature Less Than Ambient: Steel Clevis, MSS Type 1
   2. Operating Temperature Greater Than Ambient.
      a. NPS ½ to NPS2: Steel Clevis, MSS Type 1.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. To eliminate the need for seismic restraint, for piping installation where the distance from the top of the pipe to the structure is 12 inches or less for the entire run, select hanger-rod and building attachments to allow pipe movement without stress on hangers and attachments.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
   3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F piping installations.

I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
   3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F piping installations.

J. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications.

K. Comply with MFMA-103 for metal framing system selections and applications.

L. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

M. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulating plumbing piping services:

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 22 05 00 – General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Insulation Materials		X						X

B. Special Requirements
1. Product Data: For each type of insulation product listed, provide thermal conductivity and water-vapor permeance.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

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

C. Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Manville; a Berkshire Hathaway company.
   b. Knauf Insulation.
   c. Manson Insulation Inc.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.03 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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.04 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. 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. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 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.

3.03 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 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.

C. Install insulation with longitudinal seams at top and bottom of horizontal runs.

D. Install multiple layers of insulation with longitudinal and end seams staggered.

E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. 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 4 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.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. 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.

3.04 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 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. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

3.05 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

3.06 PIPING INSULATION THICKNESS

A. General
1. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch permitted to a thickness not less than 1-inch.

B. Mineral Fiber Insulation

FIBERGLASS					
FLUID NORMAL OPERATING TEMPERATURE (°F)	NOMINAL PIPE OR TUBE SIZE (inches)				
	<1	1 to < 1.5	1.5 to < 4	4 to < 8	< 8
40-60	0.5	0.5	1	1	1
<40	0.5	1	1	1	1.5

3.07 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. For all systems with an operating temperature that may be below ambient conditions, a vapor barrier must be maintained.

C. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch is permitted to a thickness not less than 1-inch.

3.08 INDOOR PIPING INSULATION SCHEDULE

A. Base insulating thickness on operating temperature unless thickness is specifically listed in section below.

B. Potable Cold Water Piping: Normal operating temperature 50°F.
1. Mineral-Fiber, Preformed Pipe Insulation, Type I.

C. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60°F:
1. Mineral Fiber: 1-inch

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes pipe, fittings, and joining methods for potable water piping.

1.02 PERFORMANCE REQUIREMENTS

A. All potable water plumbing piping, equipment, fittings, and accessories shall be capable of withstanding a maximum pressure of 125 psi and a maximum temperature of 140°F. Exceptions would include specific items of equipment where a lower operating pressure is specified.

1.03 ACTION SUBMITTALS

A. Provide materials list for pipe and fittings.

B. Provide catalog data for dielectric fittings.

1.04 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

1.05 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner’s Construction Manager no fewer than five days in advance of proposed interruption of water service.
   2. Do not interrupt water service without written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

B. Comply with NSF Standard 372 for low lead.

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:
   1. MSS SP-123.
   2. Cast-copper-alloy, hexagonal-stock body.
   3. Ball-and-socket, metal-to-metal seating surfaces.
   4. Solder-joint or threaded ends.

2.03 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys.

B. Flux: ASTM B 813, water flushable.

C. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Install piping as indicated unless deviations to layout are approved by Engineer.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from building shutoff valves where required to maintain a maximum building service pressure of 80 psi.

G. Install domestic water piping level and plumb.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. 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.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.02 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 pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Provide screwed brass union or screwed brass valve where dissimilar metals meet.

3.03 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Support vertical piping and tubing at base and at each floor.

3.04 CONNECTIONS

A. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

B. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

C. Connect domestic water piping to water-service piping with shutoff valve.

D. Connect to equipment with pipe sizes indicated but not smaller than the size of the equipment connection.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. Arrange for inspection in accordance with authority having jurisdiction.
      c. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Prepare test and inspection reports.

3.06 ADJUSTING

A. Perform the following adjustments before operation:
1. Open shutoff valves to fully open position.
2. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
3. Remove and clean strainer screens. Close drain valves and replace drain plugs.
4. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.07 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

3.08 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 22 05 00 – General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Other Items this Section		X						

1.02 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G.

2.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems (TPA):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Precision Plumbing Products.
   b. Zurn Industries, LLC.
2. Standard: ASSE 1044.
3. Description: Electronic trap primer array with adjustable frequency and duration settings. Mounted in box with cover, inlet connection, full-port ball-type shut-off valve, wye strainer, transformer, copper internal piping, and multi-port manifold.
4. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
5. Cabinet: Steel box with stainless-steel cover.
   a. Surface mounted: Mechanical rooms and service spaces.
   b. Recessed-mounted: Restrooms.

6. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
    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.
7. Vacuum Breaker: ASSE 1001.
8. Number of trap primers and number of outlets as required to serve all building trap primer connections.
9. Size Outlets: NPS 1/2.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE, VENT, AND STORM DRAIN PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes pipe, fittings, and joining methods for sanitary waste, vent and storm drain piping.

1.02 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.03 ACTION SUBMITTALS

A. Provide materials list for pipe and fittings.

B. Provide catalog data for dielectric fittings.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner's Construction Manager Authorized Representative no fewer than five business days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
   1. Standards: ASTM C 1277 and CISPI 310.
   2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
   1. Standards: ASTM C 1277 and ASTM C 1540.
   2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:
1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

2.04 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Non-pressure Transition Couplings:
a. Standard: ASTM C 1173.
b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. End Connections: Same size as and compatible with pipes to be joined.
d. Sleeve Materials:
1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Shielded, Non-pressure Transition Couplings:
a. Standard: ASTM C 1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved by Engineer.

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. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
   a. Straight tees, elbows, and crosses may be used on vent lines.
3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Do not reduce size of waste piping in direction of flow.

K. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Sanitary Waste: 2 percent downward in direction of flow. for piping NPS 3 and smaller;
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

M. Install steel piping according to applicable plumbing code.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.02 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
   c. Do not use pipe sections that have cracked or open welds.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.03 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Non-pressure transition couplings. Shielded below grade. Unshielded above grade.

3.04 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

3.05 CONNECTIONS

A. Connect waste and vent piping to the following:

B. Connect waste piping in sizes indicated, but not smaller than required by plumbing code.

C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.06 FIELD QUALITY CONTROL

A. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
      a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
      a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
      b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
      c. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
      a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
      b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
      c. Air pressure must remain constant without introducing additional air throughout period of inspection.
      d. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.07 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.08 PIPING SCHEDULE

A. All sanitary waste, storm water, and underground vent piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   2. Dissimilar Pipe-Material Couplings: Non-pressure transition couplings.

B. Aboveground, vent piping shall be the following:
   1. Galvanized-steel pipe, drainage fittings, and threaded joints.

2. Dissimilar Pipe-Material Couplings: Unshielded, Non-pressure transition couplings.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE AND STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 22 05 00 – General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section		X						

1.02 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.02 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Hub Drains:
1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap with primer connection, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

3.02 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 23 05 00

GENERAL HVAC PROVISIONS

PART 1 - GENERAL

1.01 CONTRACT DOCUMENTS

A. General HVAC provisions apply to all work performed in Division 23.

B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.

C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.

D. Particular attention is called to Instructions to Bidders, General Conditions, Drawings and Specifications, and modifications incorporated in the documents before execution of the Agreement.

E. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Engineer and Owner's Authorized Representative prior to fabrication.

F. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

1.02 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): A federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.

B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

1.03 COORDINATION

A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Owner and Engineer and secure written approval and agreement on necessary adjustments before start of work.

B. Coordinate identification systems with other trades. All mechanical systems shall use identical piping, valve, and equipment identification and regulatory signage.

1.04 SUBMITTALS AND SHOP DRAWINGS

A. General Requirements:
   1. All submittals shall be provided electronically.
   2. The Owner's Authorized Representative will be identified during the pre-construction conference. Deliver all submittals electronically in PDF format to Engineer and Owner's Authorized Representative using one of the following means:
      a. Send to e-mail address or FTP site provided at pre-construction conference.
      b. Send through online review format utilizing "Bluebeam Studio" to complete transmittal and review process.

B. Electronic Submittals: Transmit each item with approved transmittal form referencing the project, the Owner, and the Contractor. Identify and incorporate information in each electronic submittal file as follows:
   1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of each single Specification Section and transmittal form with links enabling navigation to each item. Include Division and section bookmarks in PDF files.
   2. Name file with submittal number or other unique identifier, including revision identifier.
      a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
   3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer and Owner's Authorized Representative.
   4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software or electronic form acceptable to Owner, containing the following information:
      a. Project name.
      b. Date.
      c. Name and address of Engineer.
      d. Name of Construction Manager.
      e. Name of Contractor.
      f. Name of firm or entity that prepared submittal.
      g. Names of subcontractor, manufacturer, and supplier.
      h. Category and type of submittal.
      i. Submittal purpose and description.
      j. Specification Section number and title.
      k. Specification paragraph number or drawing designation and generic name for each of multiple items.
      l. Drawing number and detail references, as appropriate.
      m. Location(s) where product is to be installed, as appropriate.
      n. Related physical samples submitted directly.
      o. Indication of full or partial submittal.
      p. Transmittal number, numbered consecutively.
      q. Submittal and transmittal distribution record.
      r. Other necessary identification.
      s. Remarks.

C. Options: Identify options requiring selection by Engineer.

D. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer and Owner's Authorized Representative on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

E. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
   3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
   4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

a. Engineer and Construction Manager reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

F. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's and Owner's Authorized Representative receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 10 days for review of each resubmittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installer's, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

1.05 ACTION SUBMITTAL CONTENT

A. Action submittal information not expressly required by the specifications will not be reviewed.

B. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.

C. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.

D. Action submittal requirements are listed in individual specification sections. The following definitions apply.
1. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
2. Catalog data: Manufacturer's standard product cut sheet.
3. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.
4. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
5. Wiring Diagrams: Power and control wiring diagrams.

6. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
7. Installation Instructions
8. Special Requirements Listed: Additional requirements indicated in individual specification sections.

E. Delegated Design
1. Delegated work will include but is not limited to the following:
   a. Section 23 05 48 “Vibration and Seismic Controls for HVAC.”
   b. Section 23 09 00 “Building Automation Systems.”
2. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Owner and Engineer.

1.06 QUALITY ASSURANCE

A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer’s recommendations.

B. Asbestos products or equipment or materials containing asbestos shall not be used.

C. Certify that each welder has passed the American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

1.07 DESIGN REQUIREMENTS

A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.

B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

1.08 CODES AND STANDARDS

A. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.

B. Work shall comply with the Americans with Disabilities Act (ADA).

1.09 TEMPORARY SERVICES

A. Provide in accordance with Section 01 50 00 “Temporary Facilities and Controls” as required for completion of work. Provide additional filters as required to keep areas clean during construction.

B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

1.10 OPERATIONS AND MAINTENANCE MANUALS

A. Provide draft Operation and Maintenance Manual for review.

B. In addition, for pdf electronic O&M submittals, provide hard copies, with quantity as determined by Owners Authorized Representative.
   1. Bind manuals in three-ring, high quality vinyl covered binders, clearly indexed and provided with thumb tabs for each item or product. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each. Index tabs shall match submittal schedule and include any additional information required for operations and maintenance, whether in submitted schedule or not.

C. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.

D. Provide copy of approved submittal for each product included in manual

E. Provide printed copy and electronic configuration files for all packaged equipment control systems furnished with equipment.

F. Mark the model actually provided where the literature covers more than one model. Include four copies of all submittal data corrected to "as-built" conditions within the manual.

G. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.

H. Manual Content: Manuals shall contain complete information for each item of mechanical electrical or other operating equipment. Include as applicable:
   1. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance
   2. Lubrication schedules
   3. Performance capacity
   4. Catalog data sheets
   5. Parts list
   6. Maintenance schedules

1.11 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from Contract Drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Alternately, provide electronically using .pdf markup of Contract Drawings.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS

A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.

B. Equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

2.02 FIRESTOPPING

A. Acceptable Manufacturers: 3M, Hilti, Tremco, Nelson Firestop Products.

B. Provide firestopping for the following:
1. All penetrations through fire resistance rated floors, walls and partitions including openings containing pipes, ducts and other penetrating items.
2. All penetrations through non-fire resistance rated floors where the vertical service riser penetrates three or more floors.

C. Firestop system shall be UL Classified for the application and correspond to those indicated by reference to designation listed by UL Fire Resistance Directory.

D. Material shall be tested in accordance to UL-1479, ASTM E-814 for the specific fire-rated construction conditions confirming to construction assembly type, penetration item type, annular space requirements, and fire-rating involved.

2.03 BELT DRIVES FOR HVAC EQUIPMENT

A. Provide belts, pulleys, and belt guards for a belt driven equipment.

B. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning
1. Standard Equipment: One or more belts with 1.35 service factor based on fan motor.
2. Critical Equipment: Two or more belts with 2.5 service factor based on fan motor shall be provided for equipment that is served by a standby power system or provides an emergency or life-safety function.

C. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

D. Motor Pulleys: Adjustable pitch for use with 7.5-hp motors and smaller; fixed pitch for use with motors larger than 7.5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

E. Belts: Oil resistant, non-sparking, and non-static; in matched sets for multiple-belt drives.

F. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

PART 3 - EXECUTION

3.01 ACCESS TO EQUIPMENT AND ACCESSORIES

A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for valves, dampers, motors, belts, and all other mechanical equipment requiring access for removal or maintenance. Type, size and exact location of access doors shall be coordinated with Owner and Engineer prior to work.

B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer’s recommendations, provide larger clearance of the two.

C. If equipment location shown on Drawings does not allow required access, notify Owner and Engineer prior to start of work.

D. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the Contract Drawings and specifications to Owner and Engineer for resolution prior to starting work.

3.02 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights, electrical outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

C. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

D. Minor Piping: Small diameter pipe runs from drips and drains, water cooling, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor piping where needed to maintain mechanical spaces clean and dry and to allow full equipment function and maintenance.

E. Interconnection of Controls and Instruments: Generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

F. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner's Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs or beams. Refer to the Owner and Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Owner's and Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

G. Switchgear Drip Protection: Do not install piping above electrical switchgear.

H. Inaccessible Equipment
1. Where the Owner's Authorized Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

I. Control Valves: Contractor shall verify that control valve port arrangement provides the intended valve function when installed as shown on Drawings. Notify Owner and Engineer of any potential conflict between the installation plans and control valve installation requirements prior to start of associated work. Any control valves installed with incorrect connections will be re-piped to provide correct operation at no expense to the Owner.

3.03 RIGGING

A. Design is based on use of available structure without modification except as specifically shown. Existing openings in building structures are planned to accommodate design scheme.

B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by the Owner and Engineer under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.

C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility.

D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Where it is not clear that the building structure has adequate capacity to support rigging, Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to existing building structure, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

E. Restore building to original condition upon completion of rigging work.

3.04 EXISTING EQUIPMENT REUSED OR RELOCATED

A. All equipment designated as existing or furnished by Owner shall be cleaned and repaired before reinstallation. Any items requiring repair shall be brought to the attention of the construction manager before the item is reinstalled. Damage not brought to the attention of the construction manager shall be deemed the result of reinstallation of the item and shall be repaired without expense to the Owner.

3.05 MECHANICAL SYSTEMS FIRESTOPPING

A. Do not cover firestop installations until they are examined by the Authority Having Jurisdiction, if required.

B. Install firestopping in accordance with manufacturer’s recommendations and conditions of product UL listing.

3.06 LUBRICATION

A. Lubricate all devices requiring lubrication prior to initial operation. Field check all devices for proper lubrication.

B. Equip all devices with required lubrication fittings or devices.

C. All lubrication points shall be accessible without disassembling equipment, except to remove access panels.

3.07 CLEANING SYSTEMS

A. General: After all equipment, pipes and duct systems are installed, system shall be thoroughly cleaned. Remove all stickers and tags from equipment or fixtures. Clean all piping systems prior to installation of insulation or painting.

B. Air Distribution Duct System:
1. Remove all debris from system before operation. Under no circumstances shall system be operated without filters. Replace filters used during construction with new filters.

2. Repair or replace any discolorations or damage to system, building finish, or furnishings resulting from Contractor's failure to properly clean system.

3.08 START UP

A. The Mechanical Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.

B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated filters, strainers, electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.

C. Verify that piping has been flushed and cleaned prior to startup.

D. The Mechanical Contractor shall perform TAB system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. TAB system-readiness checklists will be provided by the TAB Specialist. See Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.09 DEMONSTRATION

A. General: After installation is complete, demonstrate to Engineer and Owner's Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.

B. Preparation: Prior to demonstration, submit check-off list indicating completeness of submittals and certificates of compliance for review to Owner's Authorized Representative. Operate completed system for one week. Verify that control verification is complete and verification report has been approved by Owner and Engineer.

C. Arrange for demonstration with Owner's Authorized Representative, Engineer, required factory technicians, and installer at least one week in advance of demonstration.

3.10 TRAINING

A. Instruct Owner in proper operation and maintenance of equipment and systems. Instruction shall generally include topics listed in manufacturer's operations and maintenance manual. Operator instructions shall cover all aspects of manual, automatic, and safety controls. Contractor shall also instruct the Owner in the general configuration of systems and location of equipment and components. All training shall be complete 30-days after Substantial Completion.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 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

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40°C and at altitude of 3,300 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.

2.03 POLYPHASE INDUCTION 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 unless listed otherwise under section where motor is provided.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

J. Enclosure Type: Provide open drip proof enclosure, except provide totally enclosed fan cooled enclosure for the applications listed below, or as expressly specified elsewhere, or as indicated on Drawings.
1. Outdoor applications including roof exhaust fans, cooling towers, and similar equipment.
2. Fan motors mounted in an unfiltered air stream.
3. Motors on equipment related to life safety including smoke exhaust fans, fire pumps and similar equipment.
4. Motors 10 HP and larger.

K. Additional Requirements for Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Inverter Duty as defined in NEMA MG 1 with Class F temperature rise; Class H insulation.
2. 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.
3. Maximum RPM: 3600 rpm minimum, or 150% of as design motor speed, whichever is greater.
4. Speed Ratio:
   a. Constant load applications: 4:1, except 1000:1 where high turndown motor is required.
   b. Variable torque applications: 20:1, except 1000:1 where high turndown motor is required.
5. Bearing Protection Ring: For motors controlled by variable frequency drives, provide maintenance free, conductive microfiber, shaft grounding ring with a minimum of two rows of circumferential microfibers to discharge electrical shaft currents within the motor and/or its bearings. AEGIS SGR or approved equal.

L. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.04 SINGLE-PHASE ELECTRICALLY COMMUTATED MOTORS

A. General: Electrically commentated, variable-speed, DC, brushless, direct drive type. Motor rotor shall be permanent magnet type with near zero rotor losses.

B. Bearings: Heavy duty, pre-lubricated, antifriction ball bearings.

C. Motor Controller: Single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator. Motors designed for synchronous rotation and to overcome reverse rotation.
1. Operating Speed: Controllable from 100% to 20% of full speed.
2. Motor Control: Remote digital input
3. Speed Control: Provide either manual or remote speed control input as specified and as required to perform intended function:
   a. Manual: Potentiometer dial mounted on the motor.
   b. Remote modulating analog input: 4-20mA or 0-10 VDC.
4. Soft-start function to reduce inrush current at start-up
5. Overcurrent Protection
6. Thermal Overload Protection

D. Electrical Input: Single phase, 60 hertz. Voltage as required or as scheduled on drawings.

E. Efficiency: Motor shall be minimum of 70% efficient over entire operating range.

2.05 SINGLE-PHASE INDUCTION 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: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

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

3.01 EXAMINATION

A. Verify motor mounts are compatible with motor frame.

3.02 INSTALLATION

A. Motors Used with Variable Frequency Controllers: Arrange location of motor, variable frequency controller and electrical wiring to ensure the distance from motor to inverter does not exceed manufacturer recommended maximum length.

3.03 APPLICATION

A. Induction Motors
   1. Motors Less Than 1/2 HP: Single-Phase
   2. Motors 1/2 HP and larger: Polyphase.

END OF SECTION

SECTION 23 05 14

COMMON MOTOR CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Combination Motor Starters

B. Variable Frequency Drives

1.02 RELATED SECTIONS

A. Single Phase Motor Control: Refer to “23 09 30 – Field Installed Control System Components” for single phase motor control relays.

1.03 DESIGN REQUIREMENTS

A. Provide motor protection switches of the appropriate NEMA size. For units not using NEMA rating, use equivalent NEMA size.

B. Provide motor protection switches in the proper enclosure as required by NEC for the location installed unless more stringent requirements otherwise noted on the Drawings or herein. Provide secondary enclosures where primary enclosures do not conform to NEC requirements.

C. Variable speed drive control enclosures shall have a minimum Short Circuit Current Rating of 12,150 amps.

1.04 SUBMITTALS

A. Where a thermostatically controlled enclosure is required, provide complete submittal on cabinet and drive assembly showing all enclosure characteristics. Provide full load amperage, minimum circuit ampacity, and over-current protection ratings for entire drive/enclosure assembly.

PART 2 - PRODUCTS

2.01 COMBINATION MOTOR STARTER, THREE-PHASE

A. Provide molded case magnetic-only circuit breakers with rotary operating handle and lock-off facility.

B. Restrict opening of switch enclosure by the use of a defeater screw unless switch is in the OFF position.

C. Provide contactors with two overload relays.

D. 120 volt holding coil

E. Provide pilot light in cover, green LED type.

F. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off/Auto or Start/Stop momentary pushbutton.

G. Provide starters with three auxiliary contacts (N.O. and N.C.) to afford the control and interlocking required in addition to standard auxiliary holding contacts supplied with each contactor.

H. Provide control transformer with 120-volt secondary voltage of sufficient capacity to handle operating coil and associated controls. Protect transformers with fuses on primary and secondary sides of transformers as required by Code.

I. Minimum size NEMA 1.

J. Enclosure for dry, indoor locations: NEMA 1. Others as required by location.

2.02 VARIABLE FREQUENCY DRIVE CONTROLLER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: ABB.

B. General: Digital PWM controller listed and labeled to provide variable speed control of a standard NEMA Design B, 3-phase, induction motor by adjusting output voltage and frequency. UL listed as a complete assembly.

C. Performance:
1. Output Rating: 3-phase, 1 to 120 hz, current rated at 8 kHz carrier frequency.
2. Stepless motor control from 0.1% to 110% of motor base speed.
3. Ambient Temperature: 0 to 40°C
4. Capable of riding through short power dips without a controller trip.
5. Capable of starting into a rotating load regardless of direction.
6. All programmable settings held in non-volatile memory and not affected by power outages or dips.
7. Slip compensation circuit for 1% speed regulation.

D. Adjustable Control Parameters:
1. Acceleration: 0.1 to 999.9 seconds
2. Deceleration: 0.1 to 999.9 seconds
3. Current Limit: 50 to 110% of maximum rating
4. Carrier frequency: 4 to 8 khz

E. Safety Features:
1. Input surge suppression
2. External fault protection allowing wiring of remote safety contacts
3. Instantaneous overcurrent trip
4. Loss of input or output phase protection
5. Ground fault protection
6. Under and over voltage protection
7. Output phase-to-phase short circuit protection
8. Electronic overload circuit recognized by UL & NEC as adequate motor protection

F. Control and Monitoring Features:
1. Panel mounted manual start/stop speed control, manual/automatic speed control selection and run/jog selection.
2. Panel mounted digital display of voltage output, current output, input kW, totalized kWh consumption, elapsed run time, frequency output, motor rpm, time stamped fault indication, and DC bus volts.
3. Automatic restart settable by number of restart attempts and time interval between restarts.
4. Settable automatic and manual torque boosts.
5. DC braking programmable in amplitude and direction.

6. Multiple programmable preset speeds that will force VFD to preset speed upon user contact closure.
7. Relay contacts for remote indication of drive fault or motor running.
8. Multiple programmable frequency avoidance bands.
9. Multiple programmable volts/hz patterns.
10. Speed controller capable of maintaining a constant motor speed or process setpoint using field mounted process input signal and/or remote setpoint input signal. PI control capability. Remote setpoint configurable using zero and space parameters.
11. Input and output contacts programmable and capable of performing the following function:
    a. Remote Start/Stop
    b. Emergency drive shutdown
    c. Drive run/off operating status

G. Input/Output Points:
1. Digital Inputs
    a. Remote Start/Stop
    b. Emergency Stop
2. Digital Output
    a. Drive Run/Off Status.
    b. Drive Alarm.
3. Analog Input
    a. Process Variable Control Input Signal: 4 to 20 mA DC.
    b. Remote Speed Control Setpoint: 4 to 20 mA DC.
4. Analog Output Speed Feedback: 4 to 20 mA or 0 to 10 VDC.
5. Network Communications: BACnet or Modbus, Compatible with BAS system. Network outputs to include but are not limited to the following:
    a. Speed
    b. Output Frequency
    c. Current
    d. Power
    e. Status
    f. Configurable Alarm
    g. Saved kWh

H. Accessories:
1. Integral main disconnect mounted within the standard NEMA 1 enclosure to shut off power.
2. AC input line reactor: 3 phase, 3% impedance

I. Enclosure:
1. Conditioned Locations: Mount VFD and all accessories within a packaged NEMA 1 enclosure.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install devices in accordance with manufacturer's recommendations.

3.02 COMBINATION MOTOR PROTECTION SWITCH INSTALLATION

A. In finished areas, mount motor protection switches flush and install suitable coverplates.

B. Install heaters correlated with full load current of motors provided.

C. Set overload devices according to measured current of motors provided.

3.03 VARIABLE FREQUENCY DRIVE CONTROLLER

A. Maintain required clearances around unit enclosure.

B. Set overload devices according to measured current of motor.

C. Measure and document input voltage and current to drive.

D. Adjustment
1. Set V/Hz curve according to application.
2. Adjust acceleration and deceleration parameters to obtain pump/fan speed-torque acceleration requirements within motor capacity.
3. Adjust low and high frequency limit parameter for project conditions.
4. Set current limit
5. Configure VFD parameters to the motor automatically restarts after a power failure.

E. Manufacturer’s Field Service: Certified manufacturer's representative to provide the following services:
1. Inspect after installation is complete. Complete manufacturers’ installation and start-up report and submit copy to Owner and Engineer certifying that installation and operation is in accordance with manufacturer's recommendation.
2. Perform initial start-up.
3. Adjust configuration parameters for project conditions.
4. Document initial configuration. Provide hard copy and electronic copy for inclusion in O&M manuals. Provide copies for each set of manuals.
5. Provide minimum 2 hours of training including operation and maintenance. Coordinate training time with Owner’s Authorized Representative minimum 14 days prior to training. Training shall be performed after Substantial Completion and will not occur on the same day as equipment start-up.

END OF SECTION

SECTION 23 05 17

SLEEVES, SLEEVE SEALS, AND ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes sleeves, sleeve seals, escutcheons, and related materials.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.02 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.03 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated or rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. Split-Casting Brass Type: With polished, chrome-plated or rough-brass finish and with concealed hinge and setscrew.

2.04 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 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 annular clear space between piping and concrete slabs and walls recommended by manufacturer.
1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. See Section 23 05 00 – General HVAC Provisions.

3.02 ESCUTCHEONS

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.

C. Use one-piece, deep-pattern escutcheons for new piping where fittings would protrude from the wall and be exposed if standard escutcheons were used

D. Escutcheons for New Piping:
1. Finished Areas: One-piece, cast-brass type with polished, chrome-plated finish.
2. Unfinished Areas: One-piece, cast-brass type, rough brass finish.

E. Escutcheons for Existing Piping:
1. Finished Areas: Split-casting brass type with polished, chrome-plated finish.
2. Unfinished Areas: Split-casting brass type with rough brass finish.

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

G. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

END OF SECTION

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Thermometers, mounting brackets, and thermowells
2. Pressure gages and gage attachments
3. Test plugs
4. Sight flow indicators
5. Flowmeters

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Thermometers, Thermowells, and Accessories		X						
Pressure Gauges and Gauge Attachments		X						
Test Plugs		X						
Site Flow Indicators		X						
Water Flow Meters			X					

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 THERMOMETERS, THERMOWELLS, AND ACCESSORIES

A. Bimetallic-Actuated Thermometers
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ashcroft Inc.
   b. Marsh Bellofram
   c. Palmer Wahl Instrumentation Group
   d. Trerice, H. O. Co.
   e. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Liquid-filled and sealed type(s); stainless-steel with 5-inch nominal diameter.

4. Dial: Non-reflective aluminum with permanently etched scale markings and scales in degrees F.
5. Connector Type(s): Union joint, adjustable angle, rigid back, or rigid bottom selected for ease of reading. Unified-inch screw threads.
6. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
7. Stem: 0.25 or 0.375 inch in diameter; stainless-steel.
8. Window: Double strength glass or plastic.
9. Ring: Stainless-steel.
10. Element: Bimetal coil.
11. Pointer: Dark-colored metal.
12. Scale: Scale: Select the proper scale range so that the operating temperature of the material being measured will be approximately in the middle of the scale. 100°F range, or as required to span entire normal operating range whichever is greater.
13. Accuracy: Plus or minus 1 percent of scale range.

B. Filled-System Thermometers
1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ashcroft Inc.
   b. Marsh Bellofram
   c. Palmer Wahl Instrumentation Group
   d. Trerice, H. O. Co.
3. Standard: ASME B40.200.
4. Case: Sealed type, stainless-steel; 4-1/2-inch nominal diameter.
5. Element: Bourdon tube or other type of pressure element.
6. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in degrees F.
8. Pointer: Dark-colored metal.
9. Window: Double strength glass or plastic.
10. Ring: Stainless-steel.
11. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane with locking device. Alternately rigid, back or rigid bottom. ASME B1.1 screw threads. Select connector for ease of reading.
12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
13. Scale: Black printing on white. 40°F to 160°F range, 2-degree increments.
14. Accuracy: Plus or minus 1 percent of scale range.

C. Duct-Thermometer Mounting Brackets
1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

D. Thermowells
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing and PVC Piping: 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.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.02 PRESSURE GAGES AND GAGE ATTACHMENTS

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ashcroft Inc.
   b. Marsh Bellofram
   c. Palmer Wahl Instrumentation Group
   d. Trerice, H. O. Co.
   e. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type; 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, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is required.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Double strength glass or plastic.
10. Ring: Metal, Friction fit.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
12. Scale: Black printing on white. 270-degree arc, 0 to 60 range, 1 psi increments. 0 to 100 psi range, 1 psi increments, or as required for system pressure encountered. Range selected so that operating pressure approximately half of full range or maximum scale value exceeds maximum pressure, whichever scale range is greater.

B. Gage Attachments
1. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and [**piston**] [**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of brass pipe with NPS 1/4 pipe threads.
3. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

2.03 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Sisco Manufacturing Company, Inc.
2. Trerice, H. O. Co.
3. Watts, a Watts Water Technologies company
4. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless-steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200°F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic acceptable for air, gas, oil, and water. EPDM self-sealing rubber acceptable for air and water only.

2.04 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dwyer Instruments, Inc.
   2. John C. Ernst Co., Inc.
   3. Or approved.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig

E. Minimum Temperature Rating: 200°F

F. End Connections for NPS 2 and Smaller: Threaded

G. End Connections for NPS 2-1/2 and Larger: Flanged

2.05 FLOWMETERS

A. Turbine Flowmeters:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Hersey
      b. Or approved
   2. Description: Vertical turbine flowmeter with sensor and indicator. Internal strainer.
   3. Construction: Bronze maincase. Dimensionally stable thermoplastic rotor assemblies. Sapphire bearing surfaces used during high and low flow. Stainless-steel casing bolts.
   4. Register: Permanently sealed. Heat treated glass. Odometer type totalizing display. 360-degree test circle with center sweep hand and low flow detector.
   5. Temperature Range: 33°F to 130°F.
   6. Maximum Working Pressure: 150 psi
   7. Flow Range:
      a. ¾-inch: 25 gpm at 5 psi pressure drop.
      b. 1-inch: 35 gpm at 5 psi pressure drop.
      c. 1½-inch: 70 gpm at 5 psi pressure drop.
      d. 2-inch: 115 gpm at 5 psi pressure drop.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all equipment in accordance with manufacturer's recommendations.

B. Thermometers
   1. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
   2. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

C. Thermowells
   1. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
   2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
   3. Install thermowells with extension on insulated piping.

4. Fill thermowells with heat-transfer medium.

D. Pressure Gauges
1. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
2. Install valve and snubber in piping for each pressure gage for fluids (except steam).
3. Sight Install valve and syphon fitting in piping for each pressure gage for steam.

E. Test Plugs
1. Install test plugs in piping tees.
2. Location:
   a. Provide test plugs where shown on Drawings.
   b. Provide test plug immediately adjacent to each control system component that senses temperature or pressure. For differential pressure transmitters, provide test plug adjacent to both high pressure and low-pressure sensing ports.
3. Arrangement:
   a. Install so temperature probe and pressure gauge probe can easily be inserted and removed with no obstruction.

F. Sight Flow Indicators
1. Install flow indicators in piping systems in accessible positions for easy viewing.

G. Flow Meters
1. Turbine Meters: Select to match line size.

3.02 CONNECTIONS

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

3.03 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.

END OF SECTION

SECTION 23 05 23

VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Valves for HVAC service.

1.02 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. HPS: High Pressure Steam. Steam pressure greater than 15 psig.

D. LPS: Low Pressure Steam. Steam pressure 15 psig and less.

E. NRS: Non-rising stem.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.03 ACTION SUBMITTALS

A. Catalog Data: For each type of valve.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve 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 B31.1 for power piping valves.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. 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.

E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for maximum system pressures and temperatures. 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.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
2. Ball Valves:
   a. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
   b. Memory stops shall be fully adjustable after insulation is applied.
3. Gate Valves:
   a. RS Valves in Insulated Piping: Provide 2-inch stem extensions.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.02 GATE VALVES

A. NPS 2 and Smaller.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane; Crane Energy Flow Solutions.
   b. Hammond Valve.
   c. Jenkins Valves; Crane Energy Flow Solutions.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Stockham; Crane Energy Flow Solutions.
2. Class 125, NRS, Bronze Gate Valves:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron or bronze.

B. NPS 2-1/2 and Larger:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane; Crane Energy Flow Solutions.
   b. Hammond Valve.
   c. Jenkins Valves; Crane Energy Flow Solutions.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Stockham; Crane Energy Flow Solutions.
2. Class 125, NRS, Iron Gate Valves:
   a. Standard: MSS SP-70, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. NPS 14 to NPS 24, CWP Rating: 150 psig.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Disc: Solid wedge.

h. Packing and Gasket: Asbestos free.

2.03 BALL VALVES

A. NPS 2 and Smaller:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Hammond Valve.
   c. Jenkins Valves; Crane Energy Flow Solutions.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Stockham; Crane Energy Flow Solutions.
   g. Watts; a Watts Water Technologies company.
2. Two-Piece Bronze Ball Valves with Full Port and Stainless-Steel Trim:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two-piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE.
   h. Stem: Stainless-steel.
   i. Ball: Stainless-steel, vented.
   j. Port: Full.

2.04 BUTTERFLY VALVES

A. NPS 2-1/2 and Larger, Flange Connections:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Hammond Valve.
   c. Jenkins Valves; Crane Energy Flow Solutions.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Stockham; Crane Energy Flow Solutions.
2. Iron, Single-Flange Butterfly Valves:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast-iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless-steel.
   g. Disc: Aluminum, bronze, or stainless-steel.

B. NPS 2-1/2 and Larger, Grooved Connections:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Grinnell Mechanical Products.
   b. Tyco Fire Products LP.
   c. Victaulic Company.
2. 175 CWP, Iron, Grooved-End Butterfly Valves
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 175 psig.
   c. Body Material: Coated, ductile iron.
   d. Seal: EPDM.
   e. Stem: Two-piece stainless-steel.
   f. Disc: Aluminum bronze or stainless-steel.

C. NPS 2-1/2 and Larger, High Performance Lug Type, Class 150.
1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. Hammond Valve.
   c. Jenkins Valves; Crane Energy Flow Solutions.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Stockham; Crane Energy Flow Solutions.
2. Description:
   a. Standard: MSS SP-68.
   b. CWP Rating: 285 psig at 100°F
   c. Body Design: Lug-type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, cast-iron, ductile iron, or stainless-steel.
   e. Seat: Reinforced PTFE or metal.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Carbon steel.
   h. Service: Bidirectional.

D. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Actuator Extension: Suitable for insulation thickness required, but not less than 2-inches.

2.05 CHECK VALVES

A. NPS 2 and Smaller:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane; Crane Energy Flow Solutions.
   b. Hammond Valve.
   c. Jenkins Valves; Crane Energy Flow Solutions.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Stockham; Crane Energy Flow Solutions.
2. Class 125, Bronze Swing Check Valves with Bronze Disc
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze. Renewable seats and disc.

B. NPS 2-1/2 and Larger, Flanged Connections:
1. MSS SP-71 covers iron swing check valves of NPS 2 to NPS 24
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane; Crane Energy Flow Solutions.
   b. Hammond Valve.
   c. Jenkins Valves; Crane Energy Flow Solutions.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Stockham; Crane Energy Flow Solutions.
3. Class 125, Iron Swing Check Valves with Metal Seats
   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 A 126, gray iron with bolted bonnet.

e. Ends: Flanged or grooved connections to match fittings specified for associated piping
f. Trim: Bronze.

C. NPS 2-1/2 and Larger, Pump Discharge:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hammond Valve.
b. Metraflex Company (The).
c. Milwaukee Valve Company.
d. Mueller Steam Specialty.
e. NIBCO INC.
f. Spence Engineering Company, Inc.
2. All Service:
a. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
3) Body Material: ASTM A 126, gray iron.
4) Style: Compact wafer.
5) Seat: Bronze.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges to isolate 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 check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 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.

3.04 GENERAL VALVE APPLICATIONS

A. Drain Valves:
1. Where drain valves are required, include hose end connection and cap with EDPM gasket.
2. Provide drain down valves at the low point in each zone, area of service, or floor level.
3. Provide drain down valves to drain equipment.

B. Gauge Stop Valves:
1. Size to match gauge connection.

C. Strainer Blowdown Valves:
1. Match blowdown connection.
2. Provide hose end connection and cap with EDPM gasket for valves 1-inch and below.

D. Provide valves for isolation of services as shown on Drawings and at the following locations:
1. Where piping penetrates the building envelope.
2. Where piping enters the building from a tunnel.
3. At branch connections from piping risers at each floor.
4. Major branches and branches to remote equipment or fixtures for all supply and return systems.
5. As required to individually isolate all equipment and maintainable devices including automatic air vents and hydronic control valves.
6. Where piping penetrates mechanical room walls. Locate valve inside mechanical room.
7. Branch connections for utility systems including piping in utility tunnels.

E. Provide valves where recommended by equipment manufacturer's installation instructions.

3.05 VALVE SCHEDULE

A. If valve type shown on drawings is different than type indicated below, notify Engineer prior to ordering to verify type.

B. General, Chilled Water, Non-potable Water Service
1. General Shutoff Service
   a. NPS 2 and smaller: Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim
   b. NPS 2-1/2 and Larger: Iron, Single-Flange Butterfly Valves or 175 CWP, Iron, Grooved-End Butterfly Valves
2. Check Valve Service:
   a. NPS 2 and Smaller: Class 125, Bronze Swing Check Valves with Bronze Disc.
   b. NPS 2-1/2 and Larger, Standard Service: Class 125, Iron Swing Check Valves with Metal Seats.
   c. NPS 2-1/2 and Larger, Pump Discharge: Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat.
3. Drain, Gauge Stop, Strainer Blowdown: Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim.

C. Low Pressure Steam and Condensate Return
1. Steam Shutoff Service:
   a. NPS 2 and Smaller: Select one of the following.
      1) Class 125, NRS, Bronze Gate Valves
      2) Two-Piece Bronze Ball Valves with Full Port and Stainless-Steel Trim.
   b. NPS 2-1/2 and Larger:
      1) Class 125, NRS, Iron Gate Valves
2. Condensate Shutoff Service:

a. NPS 2 and Smaller: Select one of the following:
   1) Class 125, NRS, Bronze Gate Valves
   2) Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim.
b. NPS 2-1/2 and Larger: Class 125, NRS, Iron Gate Valves

3. Throttling Service:
   a. NPS 2 and Smaller: Class 125, Bronze Globe Valve.
   b. NPS 2-1/2 and Larger: Class 125 Iron Globe Valve.
4. Check Valve Service
   a. NPS 2 and Smaller: Class 125, Bronze Swing Check Valves with Bronze Disc.
   b. NPS 2-1/2 and Larger, Standard Service: Class 125, Iron Swing Check Valves with Metal Seats.
5. Drain, Gauge Stop, Steam Strainer Blow Down, Condensate Strainer Blow Down: Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim.

D. High Pressure Steam and Condensate Return.
1. Steam Shutoff Service.
   a. NPS 2 and Smaller: Select the following:
      1) Class 125, NRS, Bronze Gate Valves
   b. NPS 2-1/2 and Larger Class 125, NRS, Iron Gate Valves.
2. Condensate Shutoff Service:
   a. NPS 2 and Smaller: Use one of the following:
      1) Class 125, NRS, Bronze Gate Valves
   b. NPS 2-1/2 and Larger: Class 150, NRS, Iron Gate Valves.
3. Check Valve Service:
   a. NPS 2 and Smaller: Class 125, Bronze Swing Check Valves with Bronze Disc.
   b. NPS 2-1/2 and Larger, Standard Service: Class 250, Iron Swing Check Valves with Metal Seats.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes hangers and supports for HVAC piping and equipment.

1.02 DEFINITIONS

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

1.03 PERFORMANCE REQUIREMENTS

A. 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. Supports for multiple pipes, including pipe stands, shall be capable of supporting combined weight of supported systems, system contents, and test water.
   2. Equipment supports shall be capable of supporting combined operating weight of supported equipment and connected systems and components.

1.04 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
   1. Materials List
   2. Catalog Data
   3. Detailed Data
   4. Performance Data
   5. Wiring Diagrams
   6. Shop Drawings
   7. Installation Instructions
   8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe Hangers and Supports		X						
Thermal Hanger Shield Inserts		X						
Roof Mounted Pipe Stands		X						

1.05 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.01 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: Pre-galvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper-Coated Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. B-line, an Eaton business
b. Thomas & Betts Corporation, a member of the ABB Group
c. Unistrut, part of Atkore International
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized, ASTM A123 or A153, 2.6 MIL

2.04 INSULATION INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. National Pipe Hanger Corporation
2. Pipe Shields Inc.
3. Insulshield
4. Uni-Grip

B. General: Insulation insert for use with MSS Type 40 protection shield.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 ROOF-MOUNTED PIPE STANDS

A. Manufacturers subject to compliance with requirements, provide products by one of the following:
1. B-Line
2. Erico
3. Or approved

B. Polyethylene, polypropylene block with embedded 14-gauge hot dipped galvanized steel strut channel. Similar to B-line Dura-Blok, Erico Pyramid ST.

2.07 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Roof Pipe Stand Installation: Mount on smooth roof surface. Do not penetrate roof membrane.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying. Coordinate with Section 23 05 48 Vibration and Seismic Controls for interrelated work.

J. Install building attachments within concrete slabs or to structural steel where possible. 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.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes.

M. Insulated Piping:
1. Piping Operating Above Ambient Air Temperature:
   a. Steel Piping 4-inches and Larger: Provide MSS Type 39 Protective Saddle.
   b. All Other Piping 1-1/2-inches and larger: Provide Insulation Insert with MSS Type 40 protection shield.
   c. All Piping 1 to 1-1/4-inches: Provide MSS Type 40 protection shield.
   d. Piping 3/4 inches and smaller: None.
2. Piping Operating Below Ambient Air Temperature:
   a. All Piping 1-1/2-inches and Larger: Provide Insulation Insert with MSS Type 40 protection shield.
   b. All Piping 1-1/4-inches and smaller: Provide MSS Type 40 protection shield.
3. 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.
4. Insulation Inserts: Same thickness as piping insulation.

3.02 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.

3.03 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.

3.04 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.

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 90 00 “Painting.”

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER SPACING

A.

HYDRONIC PIPING SPACING TABLE	Maximum Horizontal Span	Maximum Vertical Spacing
Carbon Steel		
1-1/4 inch and smaller	7 feet	15
1-1/2 inch to 2-1/2 inch	10 feet	15
3 inch and larger	12 feet	15
Copper Tubing		
¾ inch and smaller	5 feet	10
1 inch to 2 inch	7 feet	10
2-1/2 inch and larger	10 feet	10
Cast Iron		
All sizes	5 feet except 10 feet, where 10-foot lengths are installed.	

3.07 ROD SIZES

A. Select rod diameter to not exceed the maximum safe load listed in Table 2 of MSS SP-58-2009.

3.08 HANGER AND SUPPORT TYPE SCHEDULE

A. Single Pipe, Hung and Uninsulated
   1. NPS ½ to NPS 3: Adjustable Steel Band Hangar, MSS Type 7.
   2. NPS 4 and Larger: Steel Clevis, MSS Type 1.

B. Single Pipe, Hung and Insulated
   1. Operating Temperature Less Than Ambient: Steel Clevis, MSS Type 1
   2. Operating Temperature Greater Than Ambient.
      a. NPS ½ to NPS2: Steel Clevis, MSS Type 1.
      b. NPS 3 and Larger: Adjustable Roller Hanger: Type 43.

C. Multiple Pipe Trapeze or Pipe Rack: Trapeze Hanger, MSS Type 59.
   1. Uninsulated Piping: Steel Strap.
   2. Insulated Piping: Adjustable Roller, MSS Type 43.

D. Single Pipe Floor Support: Adjustable Pipe Support Saddle: MSS Type 38.

E. Vertical Piping: See Section 23 05 48 “Vibration and Seismic Controls for HVAC” for riser support and restraint.

F. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

G. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

H. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

I. Use copper-plated pipe hangers and attachments for copper piping and tubing.

J. Use padded hangers for piping that is subject to scratching.

K. To eliminate the need for seismic restraint, for piping installation where the distance from the top of the pipe to the structure is 12 inches or less for the entire run, select hanger-rod and building attachments to allow pipe movement without stress on hangers and attachments.

L. Hanger-Rod Attachments: Unless otherwise indicated, provide the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F piping installations.

M. Building Attachments: Unless otherwise indicated, provide the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications.

P. Comply with MFMA-103 for metal framing system selections and applications.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 31
V-BELTS AND SHEAVES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. V-belts

B. Sheaves

1.02 DESIGN REQUIREMENTS

A. General: Belt and drive assemblies shall be rated for 150 percent of motor horsepower.

1.03 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section	X							

PART 2 - PRODUCTS

2.01 V-BELTS

A. Acceptable Manufacturer: Gates, General Rubber, Goodrich, Goodyear.

B. Grade V-Belts. Oil and heat resistant. Means of dissipating static electricity. Length stability. Multiple drive belts matched set from factory.

2.02 SHEAVES

A. Acceptable Manufacturer: Browning or approved.

B. Machined cast iron sheaves. Balanced, keyed for standard shaft and motor sizes. Provide variable pitch sheaves when available for air volume adjustment. When variable drives are not available, provide number of drives necessary to make air volume adjustment.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Adjust sheaves for proper alignment.

B. Adjust tension of belts with tension meter. Measure force required to deflect belt 1/64-inch per inch of span and adjust tension to manufacturer's recommendation.

END OF SECTION

SECTION 23 05 33

HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes heat tracing for HVAC piping with the following electric heating cables:
1. Self-regulating, parallel resistance.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.
1. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Delta-Therm Corporation.
2. Pyrotenax; a brand of nVent.
3. Raychem; a brand of nVent.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150°F.

G. Maximum Exposure Temperature (Power Off): 185°F.

H. 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.

I. Capacities and Characteristics:
   1. Refer to Drawings for electrical characteristics.

2.02 CONTROLS

A. Enclosure: Corrosion-resistant, waterproof control enclosure. Remote bulb unit with adjustable temperature range from 30 to 50°F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Electrical: 120V, 1 ph., 15 FLA. Ground fault equipment protection.

D. Remote sensing: Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

2.03 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 23 05 53 "Identification for HVAC Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
   1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
   2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Install self-regulating, parallel-resistance heat cable for the applications described:
   1. Outdoor HVAC piping that contains fluid that is subject to freezing including:
      a. Non-potable water
      b. Condenser water
      c. Cooling tower water level standpipe
      d. Cooling tower basin spray pump volute

B. Piping:

1. The heater shall be sized as shown below. The required heater output rating is in Watts per foot at 50°F. Heater selection based on 1-inch fiberglass insulation on metal piping.

PIPE SIZE	TEMPERATURE -20°F
3” or less	5 Watt
4”	8 Watt

3.03 INSTALLATION

A. Install electric heating cable across expansion joints according to manufacturer's written instructions; use slack cable to allow movement without damage to cable.

B. Install electric heating cables after piping has been tested and before insulation is installed.

C. Install electric heating cables according to IEEE 515.1.

D. Install insulation over piping with electric cables according to Section 23 07 19 "HVAC Piping Insulation."

E. Install warning tape on piping insulation where piping is equipped with electric heating cables.

F. Set field-adjustable switches and circuit-breaker trip ranges.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.05 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Design and installation of vibration isolation systems and seismic restraint components listed for new mechanical equipment, ductwork, and piping provided in Division 23 as scheduled or described herein. Exceptions include equipment whose structural attachment has been designed by the design team structural engineer including:
   a. Chiller
   b. Cooling Tower
2. Design and installation of vibration isolation systems, gravity supports, and seismic restraint components listed as follows:
   a. Exhaust Fans, EF-1 through EF-4.

1.02 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
   b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:
1. Provide a delegated submittal package comprised of drawings, details, and calculations signed and sealed by an engineer specializing in the associated work and registered in Oregon. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, and attachment and anchorage requirements.
2. All restraining devices shall have a pre-approval number from California OSHPD or some other organization acceptable to the Authority Having Jurisdiction. Where pre-approved devices are not available, provide submittals based on independent testing or calculations stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of Oregon.
3. Ductwork and Piping Restraint:

a. Provide full or half size copies of ductwork and piping plans from the Contract Documents or coordination drawings, showing location and type of each vibration isolation component and seismic restraint to be installed. Drawings shall consist of mechanically reproduced copies of the Contract Documents, or new drawings custom drafted specifically for the Work of this Project. Each drawing shall be printed on a single sheet.
b. Provide piping and ductwork restraint assembly construction and installation details. Assemblies may be pre-engineered or custom designed for the application.
c. Provide spring hangers or spring floor supports for the first three supports from any equipment that produces vibration.
d. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

4. Equipment Restraint
   a. Select vibration isolators and accessories as scheduled and as required to meet seismic restraint requirements.
   b. Provide equipment seismic restraint assembly construction and installation details. Assemblies may be pre-engineered or custom designed for the application. Include method of attachment to supporting structure.
   c. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
   d. For equipment mounted outdoors, include wind load in determining the necessary attachment and restraint requirements.
5. Calculations: Provide design calculations to verify that seismic and wind load restraint will comply with the Oregon Structural Specialty Code for the site and the building type listed.

1.04 INFORMATIONAL SUBMITTALS

A. Provide three copies of the seismic restraint system Engineer’s inspection report.

B. Provide a written authorization letter from the seismic restraint Engineer authorizing a representative to provide the inspection if a designated representative is used. Describe the representative’s qualifications.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Provide seismic and wind load design in accordance with 2014 Oregon State Structural Specialty Code and ASCE/SEI 7.

B. Refer to structural notes for project specific seismic requirements.

C. Risk Category: II

D. Component Importance Factors (Ip)
1. All components have an Ip=1.0.

2.02 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: (EP-1)
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kinetics Noise Control, Inc.
   b. Mason Industries, Inc.
   c. Vibro-Acoustics

2. Basis of Design: Mason Type Super WM Pads.
3. Fabrication: Neoprene waffle pad. 3/4-inch thick. 40 durometer. ¼-inch thick steel load distribution plate
4. Size: Factory or field cut to match requirements of supported equipment.
5. Accessories: Bolt isolator washer bushings where equipment is bolted to structure. Similar to Mason Type HG

2.03 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Double Deflection Restrained Elastomeric Isolation Mounts: (EM-1)
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kinetics Noise Control, Inc.
   b. Mason Industries, Inc.
   c. Vibro-Acoustics
2. Basis of Design: Mason Industries Type BR.
3. General: Neoprene mountings with a minimum static deflection of 0.2-inches and all directional seismic capability. Constructed with ductile iron casting containing two separated and opposing molded neoprene elements.

2.04 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibro-Acoustics

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
1. Design Requirements: Include equipment anchor bolts and auxiliary motor slide rails.
   a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
1. Basis of Design: Mason Industries WFSL
2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   a. Include supports for suction and discharge elbows for pumps.
5. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
6. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
7. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.05 RESTRAINT CHANNEL BRACINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business.

2. Hilti, Inc.
3. Mason Industries, Inc.
4. Vibro-Acoustics

B. Basis of Design: Mason Industries SSBS/SHB

C. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end. Provide other matching components. Corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.06 RESTRAINT CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibro-Acoustics

B. Basis of Design: Mason Industries SCB/H

C. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.07 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries
5. Vibro-Acoustics

B. Basis of Design: Mason Industries SASE, SAST

C. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.08 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries
4. Vibro-Acoustics

B. Basis of Design: Mason Industries SRA

C. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.09 SEISMIC-RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate locations and sizes of structural supports with locations of vibration isolators and seismic/wind restraints (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).

B. Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Intermediate supports between the restraint and structure that are not attached to the structure must be approved the project structural engineer or by the restraint manufacturer.

C. Block and shim all bases level so that all ductwork, piping and electrical connections can be made to a rigid system at the proper operating level, before isolators are adjusted. Ensure that there are no rigid connections or incidental physical contacts between isolated equipment and the building structure or nearby systems.

D. Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.

3.02 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine rough-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.04 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Install all equipment in accordance with manufacturer's recommendations and as shown on seismic design documents.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Elastomeric Isolation Pads: Provide for entire weight bearing surface of equipment base, or as recommended by equipment manufacturer.

D. Equipment Restraints:
1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:
1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet on center and longitudinal supports a maximum of 80 feet on center.
3. Brace a change of direction longer than 12 feet.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

K. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the

hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.05 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible pipe connectors at all equipment connections to allow seismic motion of piping relative to equipment. Equipment to include motor driven equipment and components connected to such equipment. Flexible connectors as listed in Section 23 21 16 "Hydronic Piping Specialties" must be selected to allow seismic movement without exceeding acceptable nozzle loads on equipment connections. Acceptable nozzle loads provided by manufacturer.

B. Install flexible pipe connectors and hoses on the equipment side of shutoff valves.

C. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 23 21 16 "Hydronic Piping Specialties" for piping flexible connections.

3.06 FIELD QUALITY CONTROL

A. After installation of seismic and vibration control devices is complete and verified as fully functional, Contractor shall notify Engineer and seismic restraint designer that equipment is ready for inspection.

B. Seismic restraint system Engineer shall inspect the installation to verify that seismic restraints are installed and adjusted in conformance with approved shop drawings and no additional restraints are necessary based on field conditions. Alternately, the restraint system Engineer may designate a qualified representative to provide the inspection. The representative may not be an employee of the installing Contractor or Subcontractor.

C. Prepare inspection reports.

3.07 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.08 HVAC VIBRATION CONTROL AND SEISMIC RESTRAINT DEVICE SCHEDULE

A.

VIBRATION ISOLATION AND SEISMIC RESTRAINT SCHEDULE			
EQUIPMENT	SPECIFICATION	SLAB ON GRADE STATIC DEFLECTION	ABOVE GRADE STATIC DEFLECTION
Pumps	Elastomeric Pads (EP-1) Flexible Connectors		
Chillers	Restrained Spring Isolators, EM-1 Flexible Connectors	--	2 inches
Cooling Towers	Restrained Spring Isolators, EM-1	--	2 inches

Exhaust Fans	Steel Bases Restrained Spring Isolators, EM-1	2 inches	3 inches

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Marking Services, Inc.
3. Seton Identification Products.

2.02 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: 0.025-inch aluminum. Predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. 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.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
2. Engraved to show white lettering on black background except for labels attached to ceiling grid or located within finished spaces shall have black lettering on white background.
3. Maximum Temperature: Able to withstand temperatures up to 160°F.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. 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. Lettering on labels attached to ceiling grid largest size practical.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, prepare equipment label schedule 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.

2.03 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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.

2.04 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Marking Services Inc.
3. Seton Identification Products.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Polished brass, 0.025-inch aluminum and having predrilled or stamped holes for attachment hardware.
2. Minimum Tag Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.
3. Fasteners: Brass wire-link chain or S-hook.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.01 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.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment. Label ceilings or ceiling grid (not the tile) to indicate key access points for equipment, valves, and other components requiring quick access or routine maintenance. Provide a clear adhesive label and bold black lettering with equipment and valve identification information.

3.03 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.04 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.
   2. Near each flange.
   3. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   4. Near penetrations and on both sides of walls, floors, ceilings, and inaccessible enclosures.
   5. At access doors, manholes, and similar access points that permit view of concealed piping.
   6. Near major equipment items and other points of origination and termination.
   7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule: Letter and background color in accordance with ANSI A13.1.

3.05 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and isolation valves for HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves with captions as indicated in the following subparagraphs:
   1. Valve-Tag Information: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch valve tag numbers.

a. Valve-Tag Information: Stamped or engraved with 1/4-inch letters and 1/2-inch valve tag numbers as listed below:
b. Valve tag number.
c. System abbreviation.
d. Area served.
e. Normal position.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Balancing air systems and equipment.
2. Balancing hydronic piping systems and equipment.
3. Balancing steam systems and equipment.
4. Testing, adjusting, and balancing existing systems and equipment.
5. Duct leakage tests.
6. Control system measurement and verification.

1.02 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB Specialist: An independent entity meeting qualification to perform TAB work.

E. TAB Project Supervisor: Certified individual employed by balancing contractor having administrative and technical responsibility for work performed under this Section.

F. TAB: Testing, adjusting, and balancing.

1.03 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details and procedures. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
1. Minimum Agenda Items:
a. Existing Conditions Report.
b. Contract Documents Examination Report.
c. Strategies and Procedures Plan.
d. Coordination and assistance of trades and subcontractors to support TAB work.
e. System-readiness checks.
f. Construction schedule allowances for TAB work.
g. TAB reports and resolution of issues identified.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in Part 1 "Quality Assurance" and Part 3 “TAB Specialist.”

B. Pre-construction TAB Reports:
1. Existing Conditions TAB Report: Within 30 days of Contractor's Notice to Proceed, submit the as specified in Part 3 “Procedures for Testing, Adjusting, and Balancing Existing Systems.”
2. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3 “Examination.”

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Instrument Calibration Report: Within 60 days of Contractor's Notice to Proceed. Report to include the following:
1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

F. Progress Reports: Submit the as specified in Part 3 “Progress Reporting.”

G. TAB reports.
1. Draft TAB Report
2. Certified Final TAB report.
3. Sound Test Report
4. Vibration Test Report
5. Verification of TAB Report

1.05 QUALITY ASSURANCE

A. All work under this Section shall be performed under the direction of the Certified TAB Supervisor.

B. TAB Specialists Qualifications: Certified by AABC or NEBB.
1. TAB Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB specialist working under the supervision of the TAB Supervisor.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1.06 FIELD CONDITIONS

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contract Document Examination:
1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
2. Confirm that balancing devices and provisions are included to facilitate TAB work. Provide listing of any devices and provisions required that are on included in the Contact Documents.
3. Contract Documents Examination Report: Based on examination of the Contract Documents, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Construction Examination:
1. Examine the approved submittals for HVAC systems and equipment.
2. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
3. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
4. Examine equipment performance data including fan and pump curves.
   a. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   b. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
5. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
6. Examine test reports specified in individual system and equipment Sections.
7. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
8. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
9. Examine control valves for proper installation and orientation for their intended function of throttling, diverting, or mixing fluid flows. Verify the pipe connections are in accordance with manufacturers recommendations.
10. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
11. Examine system pumps to ensure absence of entrained air in the suction piping.
12. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Strategies and Procedures Plan: Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Prepare system-readiness checks of HVAC systems and equipment to be executed by the Mechanical Contractor to verify system readiness for TAB work. Include, at a minimum, the following:
1. Airside:
   a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
   b. Duct systems are complete with terminals installed.
   c. Volume dampers are open and functional.
   d. Clean filters are installed.
   e. Fans are operating, free of vibration, and rotating in correct direction.
   f. Variable-frequency controllers' startup is complete, and safeties are verified.
   g. Automatic temperature-control systems are operational.
   h. Windows and doors are installed.
   i. Suitable access to balancing devices and equipment is provided.
2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete, and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3. Steam and Condensate:
a. Verify leakage and pressure tests on steam and condensate systems have been satisfactorily completed.
b. Piping is complete.
c. Systems are cleaned.
d. Strainers are pulled and cleaned.
e. Control valves are functioning per the sequence of operation.
f. Shutoff and balance valves have been verified to be 100 percent open.
g. Pumps are started and proper rotation is verified.
h. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
1. Comply with requirements in ASHRAE 62.1, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
1. After testing and balancing, install test ports and duct access doors as required in Section 23 33 00 "Air Duct Accessories." Otherwise, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Verify that motor starters are equipped with properly sized thermal protection.

F. Check dampers for proper position to achieve desired airflow path.

G. Check for airflow blockages.

H. Check condensate drains for proper connections and functioning.

I. Check for proper sealing of air-handling-unit components.

J. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ductwork."

K. Fan Pressure Measurements:
1. Measure static pressure directly at the fan outlet or through the flexible connection.
2. Measure static pressure directly at the fan inlet or through the flexible connection.
3. Measure static pressure across each component that makes up and air-handling system.

L. Air Inlets and Outlets:
1. Supply Diffusers: Set airflow patterns of adjustable outlets for proper distribution without drafts.

M. Control Parameters and Setpoints:
1. Perform field verification and calibration of BAS airflow and water flow transmitters.
   a. Airflow verification shall be performed by duct traverse in straight section of ductwork to provide measurement accuracy of +/- 5% better.
   b. Provide a summary report of final BAS calibration parameters in report.
6. Record verification measurement. calibration parameters, and setpoints in Final TAB Report.

3.05 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

D. Flow Adjustments:
1. Perform temperature tests after flows have been balanced.
2. Position 3-way control valves to bypass the coil and adjust the bypass valve to maintain design flow.
3. For pressure independent flow devices, measure differential pressure and verify that it is within manufacturer's specified range.
4. Adjust memory stops on balancing devices.

E. Pump Pressure Measurements:
1. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

3. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

F. Control Parameters and Setpoints:
1. Record verification measurement. calibration parameters, and setpoints in Final TAB Report.

3.06 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Control Parameters and Setpoints:
1. Steam and Condensate Flow Transmitters: Perform field verification and calibration of BAS flow transmitters. Verification shall be performed to provide measurement accuracy of +/- 2 % or as scheduled on Drawings.
2. Record verification measurement. calibration parameters, and setpoints in Final TAB Report.

3.07 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.08 PROCEDURES FOR COOLING TOWERS

A. Balance total condenser-water flows to towers. Measure and record the following data:
1. Condenser-water flow to each cell of the cooling tower.
2. Entering- and leaving-water temperatures.
3. Wet- and dry-bulb temperatures of entering air.
4. Wet- and dry-bulb temperatures of leaving air.
5. Condenser-water flow rate recirculating through the cooling tower.
6. Cooling-tower spray pump discharge pressure.
7. Condenser-water flow through bypass.
8. Fan and motor operating data.

3.09 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:
1. Entering- and leaving-water temperature.

2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.10 PROCEDURES FOR MOTORS

A. Motor Measurement and Verification:
1. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   a. Manufacturer's name, model number, and serial number.
   b. Motor horsepower rating.
   c. Motor rpm.
   d. Phase and hertz.
   e. Nameplate and measured voltage, each phase.
   f. Nameplate and measured amperage, each phase.
   g. Starter size and thermal-protection-element rating.
   h. Service factor and frame size.
2. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

B. Motor Speed Adjustments:
1. Obtain approval from Engineer for adjustment of fan motor speeds higher than the motor synchronous speed. indicated speed for induction motors
2. Obtain approval from Engineer prior to making fan-speed adjustments that result in motor operation above the motor RLA. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required motor amperage.

3.11 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
1. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
2. Verify that the system static pressure sensor is located in the duct or piping system as specified or as shown on Drawings.
3. Verify the operation of valve and damper actuators. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions in Final Report.

3.12 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work. TAB shall be performed to achieve system performance shown on Drawings and as specified. TAB shall be performed for interrelated equipment and systems which are not otherwise modified, but where testing, adjusting, and balancing is required to achieve overall system performance and to maintain existing equipment and systems that are unmodified operating at preconstruction conditions.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
   4. Balance each air outlet.

B. Perform preconstruction inspection and measurement operating condition of existing equipment interconnected with new work and will remain and be reused. Preconstruction tests shall be performed within 30 days of the Contractors Notice to Proceed and prior to the beginning of any construction work and other activities that affect the performance of existing systems and equipment. If measurements are not performed as specified, comprehensive testing, adjusting, and balancing shall be performed for all interconnected systems and equipment.
   1. Measure and record the operating speed, airflow, and static pressure of each fan.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the refrigerant charge.
   4. Check the condition of filters.
   5. Check the condition of coils.
   6. Check the operation of the drain pan and condensate-drain trap.
   7. Check bearings and other lubricated parts for proper lubrication.
   8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

C. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

D. Prepare an Existing Conditions TAB Report documenting inspections and measurements.

3.13 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 FINAL REPORT

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

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers. Test reports shall be fully executed reports forms confirming to standard NEBB or AABC documentation standards.
   5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Fan drive settings including settings and percentage of maximum pitch diameter.
      e. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.
   6. Balancing stations.
   7. Position of balancing devices.

E. Instrument Calibration Reports:

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

3.15 VERIFICATION OF TAB REPORT

A. Engineer or Owner’s Construction Manager may randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

B. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

C. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

D. If TAB work fails, proceed as follows:
    1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
    2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

E. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions. Prepare Seasonal Test Report of measurements and adjustments.

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulation of HVAC ductwork.

1.02 ACTION SUBMITTALS

A. Provide submittals in accordance with Section 23 05 00 – General HVAC Provisions as follows:
1. Provide catalog data for all products. Indicate thermal conductivity, water vapor permeance, and jackets (both factory and field applied) if any.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

A. If duct leak testing is required, schedule insulation application after systems are tested and, where required. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 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 C 871.

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

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

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation
      b. Johns Manville, a Berkshire Hathaway company
      c. Knauf Insulation

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation
      b. Johns Manville, a Berkshire Hathaway company
      c. Knauf Insulation

2.02 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.03 MASTICS

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

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180°F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220°F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

2.04 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F.
4. Color: Aluminum.

B. Vinyl and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F.
4. Color: White.

2.05 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft paper backing; complying with ASTM C 1136, Type II.
2. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.06 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.07 SECUREMENTS

A. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.
5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge.
   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 duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. 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.

3.04 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (Not Fire Rated): Install insulation continuously through walls and partitions.

3.05 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, and manufacturer’s recommended percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install support pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over-compress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Owner reserves the right to perform tests and inspections.

B. Tests will include removing field-applied jacket and insulation in layers in reverse order of their installation for each duct system schedule as directed by the Owner.

C. If sample inspection reveals noncompliance with requirements, all similar insulation applications will be considered defective Work and will be replaced at no expense to the Owner.

3.07 INDOOR DUCT INSULATION SCHEDULE

A. Insulate all plenums and ductwork as scheduled with the following exceptions.
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

B. Insulate ductwork requiring condensation control including:
1. Supply ductwork located in conditioned spaces where the air supply temperature may be below the space temperature.
2. Outside air ductwork.
3. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Insulate supply and return ductwork located indoors in mechanical rooms, unconditioned spaces, or inside a wall between a conditioned and unconditioned space.
1. Mineral-Fiber Board: 2 inches thick and 1.5-lb/cu. ft. nominal density.

D. Ductwork located inside an exterior wall.

1. Mineral-Fiber Blanket: 3 inches thick and 1.5-lb/cu. ft. nominal density.

E. Supply and outside air plenums located in mechanical rooms or unconditioned spaces.
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

END OF SECTION

SECTION 23 07 16

HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulation of HVAC equipment

1.02 ACTION SUBMITTALS

A. Provide submittals in accordance with Section 23 05 00 – General HVAC Provisions as follows:
   1. Provide catalog data for all products. Indicate thermal conductivity, water vapor permeance, and jackets (both factory and field applied) if any.

1.03 QUALITY ASSURANCE

A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.05 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.06 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.
   b. Armacell LLC.

E. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Knauf Insulation.

F. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb./cu. ft. or more. Thermal conductivity (k-value) at 100°F is 0.29 Btu x in./h x sq. ft. x degree F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Knauf Insulation.

G. Pre-manufactured Removable Insulation Systems
1. General: Removable and Re-useable insulation covers, custom engineered and manufactured for the specific application. Similar to Fit Tight Covers.
2. Construction
   a. Jacket and Liner: Silicon Impregnated Fiberglass Fabric
   b. Insulation: 1-inch Type E Glass Mat
   c. Fastening: 1-inch straps and stainless-steel D-rings.
   d. Thread: Kevlar/stainless-steel thread.

2.02 ADHESIVES

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

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.03 MASTICS

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

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180°F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220°F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

2.04 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 C 1136, Type I.

2.05 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. Childers Brand: H. B. Fuller Construction Products
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.

2.06 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. 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. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.07 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment 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. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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 insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 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.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. 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.

O. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not over-compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum at least 0.050 inches thick or stainless-steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.05 FIELD-APPLIED JACKET INSTALLATION

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

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.06 FIELD QUALITY CONTROL

A. Testing: The Owner reserves the right to perform tests and inspections of selected insulation sites at Owner’s cost for testing and repair.

B. Tests will include removing field-applied jacket and insulation in layers in reverse order of their installation for each piping system scheduled. If testing reveals defective work, all similar insulation sites will be considered defective, and Contractor will be responsible for cost of inspection and repair for all such sites.

3.07 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated as scheduled.

C. Chilled-water pump insulation shall be one of the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
   2. Pre-manufactured Removable Insulation System.

D. Chilled-water air-separator insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Pipe and Tank: 1 inch thick.

E. Chilled-water buffer tank installation shall be the following:
   1. Flexible Elastomeric: 1 inch thick.

F. Cooling tower collection basin spray pump shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Pre-manufactured Removable Insulation System

3.08 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. Equipment, Concealed:
   1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. None.

3.09 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. Equipment, Concealed:
1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
1. Aluminum, Stucco Embossed: 0.032 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
1. Aluminum, Stucco Embossed: 0.032 inch thick.

END OF SECTION

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulating of above grade HVAC piping.

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions.
   1. Catalog Data.
   2. For each type of product listed, provide thermal conductivity and water-vapor permeance.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.

B. Surface-Burning Characteristics: Products shall have flame spread and smoke developed ratings based on test procedures in accordance with NFPA-255 and UL 723. Rating shall be indicated on the product or on the shipping containers.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 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 C 871.

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

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

E. 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, provide products by one of the following:
   a. Pittsburg Corning Corporation
2. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.
   b. Armacell LLC

G. Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Manville, a Berkshire Hathaway company
   b. Knauf Insulation
   c. Manson Insulation Inc.
2. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Pre-manufactured Removable Insulation Systems
1. General: Removable and Re-useable insulation covers, custom engineered and manufactured for the specific application. Similar to Fit Tight Covers.
2. Construction
   a. Jacket and Liner: Silicon Impregnated Fiberglass Fabric
   b. Insulation: 1-inch Type E Glass Mat
   c. Fastening: 1-inch straps and stainless-steel D-rings.
   d. Thread: Kevlar/stainless steel thread.

2.02 ADHESIVES

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

B. Flexible Elastomeric: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140°F.

E. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.03 MASTICS

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

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180°F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220°F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

2.04 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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.05 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Johns Manville, a Berkshire Hathaway company
b. P.I.C. Plastics, Inc.
c. Proto 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.

2.06 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 11.5 mils.

3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. 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. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 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 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.

C. Install insulation with longitudinal seams at top and bottom of horizontal runs.

D. Install multiple layers of insulation with longitudinal and end seams staggered.

E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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.

J. Apply insulation and jacket manufacturer approved adhesives, mastics, and sealants at recommended coverage rate and wet and dry film thicknesses.

K. 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 4 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.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. 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.

O. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.04 PENETRATIONS

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

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

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

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 23 05 00 "General HVAC Provisions" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 23 05 00 "General HVAC Provisions."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe

diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at the following:
1. Valves
2. Flanges and unions requiring access to allow equipment service.
3. Mechanical couplings requiring access to allow equipment service.

E. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.06 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.

3.07 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.

3.08 INSTALLATION OF MINERAL-FIBER INSULATION

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

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.09 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.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 FIELD QUALITY CONTROL

A. Testing: The Owner reserves the right to perform tests and inspections of selected insulation sites.

B. Tests will include removing field-applied jacket and insulation in layers in reverse order of their installation for each piping system scheduled. If testing reveals defective work, all similar insulation sites will be considered defective, and Contractor will be responsible for cost of inspection and repair.

3.11 PIPING INSULATION THICKNESS

A. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch permitted to a thickness not less than 1-inch.

B. Insulation installed over heat trace for freeze protection: 1-inch thickness

C. Cellular Glass Insulation

1.

CELLULAR GLASS					
FLUID NORMAL OPERATING TEMPERATURE (°F)	NOMINAL PIPE OR TUBE SIZE (inches)				
	<1	1 to < 1.5	1.5 to < 4	4 to < 8	≥ 8
0-60	0.5	0.5	1	1	1
<40	0.5	1	1	1	1.5

D. Flexible Elastomeric Insulation

1.

FLEXIBLE ELASTOMERIC					
FLUID NORMAL OPERATING TEMPERATURE (°F)	NOMINAL PIPE OR TUBE SIZE (inches)				
	<1	1 to < 1.5	1.5 to < 4	4 to < 8	≥ 8
>350	-	-	-	-	-
251-350	-	-	-	-	-
201-250	2.5	2.5	2.5	3	3
141-200	1.5	1.5	2	2	2
105-140	1	1	1.5	1.5	1.5
40-60	0.5	0.5	1	1	1
<40	0.5	1	1	1	1.5

E. Mineral Fiber Insulation

1.

FIBERGLASS					
FLUID NORMAL OPERATING TEMPERATURE (°F)	NOMINAL PIPE OR TUBE SIZE (inches)				
	<1	1 to < 1.5	1.5 to < 4	4 to < 8	≥ 8
>350	5	5	5	5	5
251-350	3.5	4.5	4.5	4.5	4.5
201-250	2.5	2.5	2.5	3	3
141-200	1.5	1.5	2	2	2
105-140	1	1	1.5	1.5	1.5
40-60	0.5	0.5	1	1	1
<40	0.5	1	1	1	1.5

3.12 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. For all systems with an operating temperature that may be below ambient conditions, a vapor barrier must be maintained.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water: Normal operating temperature range 42°F to 62°F:
1. Mineral Fiber

B. Steam and Steam Condensate: Normal operating temperature 275°F:
1. Mineral Fiber

C. Condensate Return, 212°F:
1. Mineral Fiber

3.14 OUTDOOR PIPING INSULATION

A. Chilled Water, Normal operating temperature range 42°F to 62°F:
1. Cellular Glass

B. Heat traced piping including condenser water supply and return, non-potable make-up water, and drain piping. Normal operating temperature range 40°F to 95°F:
1. Flexible Elastomeric

3.15 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, Subject to Damage: Piping located in mechanical rooms within 6-feet of floor level, across passageways, or otherwise exposed to physical damage as determined by the Owners Authorized Representative:
1. Aluminum, Corrugated: 0.024 inch thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Provide jacketing for all outdoor insulated piping.

B. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

C. Piping, Exposed:
1. Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION

SECTION 23 08 12

TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe testing

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section								X

B. Special Requirements:
1. Submit test log

PART 2 - PRODUCTS

2.01 LOG

A. Testing: Provide a testing log including the following information:
1. Date of test
2. Description of Section tested
3. Test results
4. Minimum acceptance requirements

PART 3 - EXECUTION

3.01 PIPE TESTING

A. General Details of Test:
1. Instruments, vessels, equipment, and accessories which cannot withstand the test pressure required of attached piping shall be isolated from the piping. Remove or block and vent directly operated or self-contained regulators. Each part of a pipe system shall be tested for the time specified for the given class of test.
2. Piping and vessels shall be vented when draining them to prevent their collapse by vacuum.
3. The test crew shall seat valves under test by normal hand tightening or by normal use of operator furnished with valve. Over-tightening of a valve in an effort to make it hold will be cause for rejection of the valve.
4. The pipe system installer shall provide all necessary connections, vents and drains to test and drain the system completely.

5. No testing shall be done when the ambient space temperature is below 40°F.
6. Allowance shall be made by the inspector for variations of pressure and volume due to temperature changes in determining satisfactory maintained test pressure.
7. The inspector shall check the test pressure at the beginning and end of each test before acceptance of the system.
8. Pipe systems shall be tested and accepted before insulation, paint, or other covering or coating is applied. The only exceptions are for those parts, including vessels, which have been painted, covered or coated and have had previous certification tests.

B. Hydronic Piping:
1. Hydrostatic Test - for Design Pressures are shown:

a. Typical Services:	Design Pressure
Chilled water piping	125 psig
Heating water piping	125 psig
Heat recovery water piping	125 psig

   b. The final test pressure shall be 1.5 times the design pressure.
   c. An initial test pressure of 25 psig shall be applied and a visual inspection of the piping system conducted for leaks. The pressure shall then be raised to .75 times the design pressure and rechecked for leaks, after which the final test pressure shall be applied, and a final inspection of the piping system performed.
   d. Clean domestic water shall be used as the test medium.
   e. Trapped air shall be removed.
   f. A test gauge with a minimum 4-1/2-inch diameter dial and a test pressure reading between 1/2 to 3/4 of full scale shall be used.
   g. The final test pressure shall be held for 4 hours then visually inspected for leaks. Pressure loss during the 4-hour test period may be cause for rejection of the system.

C. Steam and Condensate Piping:
1. Hydrostatic Test - for Design Pressures are shown:

a. Typical Services:	Design Pressure
b. High pressure steam piping	125 psig
High pressure condensate return	125 psig
Low pressure steam piping	15 psig
Low pressure condensate return	15 psig

   c. The final test pressure shall be 1.5 times the design pressure.
   d. An initial test pressure of 10 psig shall be applied and a visual inspection of the piping system conducted for leaks. The pressure shall then be raised to .75 times the design pressure and rechecked for leaks, after which the final test pressure shall be applied, and a final inspection of the piping system performed.
   e. Clean domestic water shall be used as the test medium.
   f. Trapped air shall be removed.
   g. A test gauge with a minimum 4-1/2-inch diameter dial and a test pressure reading between 1/2 to 3/4 of full scale shall be used.
   h. The final test pressure shall be held for 4 hours then visually inspected for leaks. Pressure loss during the 4-hour test period may be cause for rejection of the system.

D. Low Pressure Natural Gas Piping:
1. Test at 6" h.g. or 3 psi for minimum 10 minutes with no pressure drop. Increments equivalent to 0.1" psi. Use air or other inert gas for test.
2. After pressure test, check all gas outlets closed. Turn gas on. Observe gas meter for flow. Locate and repair leaks if meter indicated flow.

END OF SECTION

SECTION 23 09 10

BUILDING AUTOMATION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work hereunder includes a complete and operational, fully tested, distributed logic, direct-digital control system for control of HVAC systems and equipment. Associated work includes but is not limited to:
1. Replacement of existing pneumatic control systems.
2. Removal of existing pneumatic devices, tubing, switches, and replaced by new control components. Not all components which must be removed are indicated directly on Drawings or in specifications.
3. Refurbishment of selected existing control dampers, devices, and components that will remain in service.
4. A network of stand-alone, microprocessor-based building controllers, custom application controllers, and application specific controllers.
5. Communication, control wiring, power supplies, power connections, and power wiring as required.
6. Building operation and energy management software and related programming.
7. Field Mounted Devices as specified in SECTION 23 09 30 – FIELD INSTALLED CONTROL SYSTEM COMPONENTS.
8. Control sequences as specified in Section 23 09 50 – AUTOMATIC CONTROLS SEQUENCE OF OPERATIONS.
9. Other materials and devices not shown as part of other work but necessary to provide mechanical and electrical system control and monitoring sequences specified.

1.02 RELATED SECTIONS

A. SECTION 23 09 30 – FIELD INSTALLED CONTROL SYSTEMS COMPONENTS

B. SECTION 23 09 50 – AUTOMATIC CONTROLS SEQUENCE OF OPERATIONS

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products This Section								X

B. Special Requirements:
1. Provide all control submittals including Sections 23 09 10 – BUILDING AUTOMATION SYSTEMS, 23 09 30 – FIELD INSTALLED CONTROL SYSTEM COMPONENTS, and 23 09 50 – AUTOMATIC CONTROLS SEQUENCE OF OPERATIONS.

2. Submittals prior to starting work:
    a. Submit in accordance with Division 1 and Section 23 05 00 – GENERAL HVAC PROVISIONS within 6 weeks of project award.
    b. All required schematics and plans prepared on AutoCAD 2010 or higher.
    c. When manufacturers' product information applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the pertinent specification or drawing.
    d. Building Automation System Hardware:
        i. Provide a complete bill of materials of building automation control system hardware indicating quantity, manufacturer, model number, and technical data. Technical data shall include performance curves, product specifications sheets, and installation/maintenance instructions.
        ii. Network Communication Diagrams: Provide schematic diagram showing all BAS panels, communications cabling, and termination points. Identify power requirements and power source for each BAS panel. Identify equipment each BAS panel is controlling. Show termination numbers.
        iii. Provide plans indicating locations of all BAS hardware.
        iv. Provide panel interior and exterior layout details for prefabricated control panels. Details shall include equipment layout and routing of wiring.
        v. Provide two copies of programming manuals for each BAS controller furnished.
        vi. Provide a listing and description of all available training programs. Indicate a cost for each location that the training program is available.
    e. Controlled Systems:
        i. Provide an instrumentation list for each controlled system including all controlled system elements in table format. Tables to show element name, type of device, manufacturer, model number, and product data sheet number.
        ii. Provide a schematic diagram of each controlled system. Include control points labeled with appropriate point names. Graphically show the location of all control elements.
        iii. Provide a schematic wiring diagram for each controlled system. Label all elements. Label all terminals.
        iv. Provide a mounting, wiring, and routing plan-view drawing. Layout to account for HVAC, electrical, and other system design and layout requirements.
        v. Provide a complete description of the function of each controlled system including sequence of operation.
        vi. Provide a points list for each system controller including both input and output (I/O) points. Note point designations, point function, controlled device associated with the I/O point, location of the I/O device, and point alarm requirements.
3. Submittals during construction
    a. Database information: Four weeks prior to system start-up, provide two copies of complete database information for Engineer's and Owner's records. Database information will not be reviewed for conformance with Contract Documents. Database information shall include system configuration parameters, point definitions, alarm and trending parameters, control parameters, and control software programs. Specifically document all control functions that cannot be performed by applications specific controllers using pre-programmed control routines or which must be performed by supervisory control from a general-purpose controller.
    b. Graphics: Provide pdf copies of all proposed graphics screens for review prior to installation.
    c. Contractor Verification: Provide Contractor checkout and testing documentation.
4. Closeout Submittals
    a. Submit in accordance with Division 1.
    b. Record documents shall include the following.

i. Project record drawings. Project record drawings will be as-built versions of the shop drawings. Include one set of magnetic media including CAD drawings in .DWG format.
ii. Provide copy of testing and commissioning reports. Include trend logs used for verification.
iii. Material to be included in Project Operation and Maintenance Manuals
(i) Names, addresses and 24-hour telephone numbers of installing contractors and the service representatives for each.
(ii) Operators manual with procedures for operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
(iii) A listing and documentation of all custom software created using the programming language including set points, tuning parameters, and object database.
(iv) A list of recommended spare parts with part numbers and suppliers.
(v) Recommended preventive maintenance procedures for all system components including a schedule of tasks, time between tasks, and task descriptions.
iv. Supplemental Record Information
(i) Two sets of programming manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, and use of the program editor.
(ii) Two sets of engineering, installation, and maintenance manuals explaining how to design and install new points, panels, and other hardware; preventive maintenance procedures; how to debug hardware problems; and how to replace or repair hardware.
(iii) One set of magnetic/optical media containing backup files of the software and database.
(iv) One set of magnetic/optical media containing files of all color graphic screens created for the project.
(v) One set of complete original issue documentation for third-party software including installation and maintenance instructions.
(vi) One set of complete original issue diskettes for all operating systems, programming language, operator workstation software, and graphics software.
(vii) One set of licenses, guarantees, and warranty documents for all system equipment.

1.04 CODES AND STANDARDS

A. Work, materials, and equipment shall comply with all local, state, and federal codes and ordinances including but not limited to the following.
1. Each BASP shall be listed under UL916 (Energy Management Systems), UL864-UDTZ (Signal Systems Unit) and shall be tested to comply with sub-part J of Part 15 FCC rules for Class A computing equipment.

1.05 PERFORMANCE REQUIREMENTS

A. Performance Standards:
1. Graphic Display: System shall display a graphic with 20 dynamic points and all current data within 10 seconds.
2. Graphic Refresh: System shall update a graphic with 20 dynamic points and all current data at no greater than 8 second intervals.
3. Object Command. The maximum time between an operator command of a binary object and the reaction of the commanded device shall be 2 seconds. The maximum

time between an operator command of an analog object and the start of object adjustment shall be 2 seconds.

4. Object Scan. All changes of state and change of analog values will be transmitted on system communications networks such that any data used or displayed at a controller will have been current within the previous 6 seconds.
5. Alarm Response Time. The maximum time from an object going into alarm to alarm annunciation at the workstation shall not exceed 45 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. Contractor shall select execution times consistent with the process under control.
7. Performance. Programmable controllers shall be able to execute BAS PID control loops at a selectable frequency of a least once per second. The controller shall scan and update the process value and output generated at the same frequency.
8. Multiple Alarm Annunciations. All workstations on the network must receive alarms within 5 seconds of each other.
9. Reporting Accuracy. The system shall report all values with an end-to-end accuracy no less than listed in Table 1.
10. Stability of Control. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

TABLE 1
REPORTING ACCURACY

Measured Variable	Reported Accuracy
Space Temperature	±1°F
Ducted Air	±1°F
Outside Air	±2°F
Water Temperature	±1°F
Delta-T	±0.25°F
Water Flow	±5% of full scale
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±0.1 in. w.g.
Air Pressure (space)	±0.01 in. w.g.
Water Pressure	±2% of full scale (*see Note 2)*
Electrical (A, V, W, Power Factor)	5% of reading *(see Note 3)*
Carbon Dioxide (CO_2)	±50 ppm
Note 1: 10%-100% of scale	
Note 2: For both absolute and differential pressure	
Note 3: Not including utility-supplied meters	

Table 2
CONTROL STABILITY AND ACCURACY

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.01 in. w.g.	0-6 in. w.g.
Airflow	±10% of full scale	-0.1 to 0.1 in. w.g.
Space Temperature	±2.0°F	
Duct Temperature	±3.0°F	
Humidity	±5% RH	
Fluid Pressure	±1.5 psi ±1.0 in. w.g.	1-150 psi 0-50 in. w.g. differential

1.06 QUALIFICATIONS

A. Control contractor to have in-house, factory-trained and factory-authorized installers and programmers.

B. All products used in this application, except for those specifically indicated for reuse, shall be new and under current manufacture and shall be the most recent version offered by the manufacturer for the application. Spare parts shall be available from the manufacturer for at least five years after Final Completion.

1.07 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Control contractor to coordinate with other trades to ensure delivery and correct installation of products furnished but not installed under this section. Coordination to include a review of schedule, manufacturer's installation requirements, and equipment locations. Such products include but are not limited to the following:
   1. Control Valves

1.08 UPDATES

A. Provide at no extra cost all software and firmware updates that become available from the manufacturer during the warranty period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Alerton, installed by Environmental Controls Corporation; Automated Logic, installed by Clima-Tech; JCI, installed by local or regional factory branch; Siemens Industries, installed by local or regional factory branch.

2.02 COMMUNICATIONS

A. Architecture: Network architecture shall consist of three levels; a management level network, a first-tier BAS controller level, and a second-tier BAS controller level. As an alternative, the management level and first-tier BAS controller level levels may be combined into a single level.
   1. Management Level Network:
      a. The Management Level Network will be used for communications between workstations or workstations and BAS building level controllers.
      b. The Management Level Network shall reside on industry standard Ethernet using standard TCP/IP or ARCNET.
      c. The Management Level Network shall operate at a minimum of 2.5 M baud with full peer-to-peer network communication.
   2. First-tier BAS controller level:
      a. The first-tier controller level will be used for communications between first-tier controllers.
      b. The first-tier BAS controller level shall reside on industry standard Ethernet using standard TCP/IP or ARCNET.
      c. The first-tier BAS controller level shall operate at a minimum of 2.5 M baud with full peer-to-peer network communication.
   3. Second-tier BAS controller level:
      a. The Second-tier BAS controller level will be used for communications between first-tier BAS controllers and custom programmable or application specific controllers.
      b. The Second-tier BAS controller level shall be performed using peer-to-peer or MS/TP communications protocols.
      c. Second-tier communications shall operate at a minimum speed of 9600 baud.

B. Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for network communications.

C. Communications shall provide operator interface and value passing that is transparent to the system architecture as follows:

1. Connection of an operator interface to any controller on the system will allow the operator to interface with all other controllers as if that controller were directly connected. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any controller on the system.

D. All database values (e.g., objects, software variables, custom programming variables) of any controller shall be readable by any other controller on the system. Value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform system value passing.

E. The network shall have the following minimum capacity:
1. The first-tier network shall support 50 first-tier controllers.
2. Each first-tier controller shall support 50 second-tier controllers.
3. The entire system shall have the capacity for 12,500 input/output objects associated with first-tier controllers, custom application controllers, or application specific controllers.

2.03 WORKSTATION GRAPHICS

A. System Graphics: Provide graphic oriented operator workstation software. System shall display up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for operator to easily move between graphic displays and change the size and location of graphic displays on the screen. System graphics modifiable while on line including addition, deletion, or changes to objects on a graphic screen. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall show animation by shifting image files based on object status.

B. Custom graphic files created by using graphics generator package furnished hereunder. Graphics package shall use mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics package shall also function to capture or convert graphics from other programs such as Designer or AutoCAD.

C. Graphics Library. Furnish a complete library of standard HVAC equipment graphics including chillers, boilers, air handlers, terminal units, fan coils, unit ventilators, etc. Library to also include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library provided in file format directly compatible with graphics package.

2.04 SYSTEM APPLICATIONS SOFTWARE

A. General: System applications are edited and archived on a separate portable or campus facilities controls workstation but executed on the appropriate building controller.

B. Automatic System Database Save and Restore: Each workstation shall store on the hard drive a copy of the current database of each controller. The database shall update whenever a change is made in any system panel. Storage of the database shall be automatic and not require operator intervention. The first workstation to detect a database loss, shall automatically restore the database for that controller. Automatic restoration may be disabled by the operator.

C. Manual Database Save and Restore: Authorized operators able to save the database from any system panel. Operator able to clear a panel database and manually initialize a download of a specified database to any panel on the system.

D. System Configuration: Workstation software shall provide a method to configure the system to allow for future systems changes or additions.

E. On-line Help: Provide a context-sensitive, on-line help system. On-line help available for all applications and shall provide data relevant to screen displayed.

F. Security: Each operator shall be required to log on to the system with a user name and password to view, edit, add, or delete data whether accessing system from the workstation, portable operator's terminal, or proprietary portable terminal. System security selectable for each operator. System supervisor shall set passwords and security levels for all other operators. Each operator password shall restrict viewing and changing of each system application, editor, and object. Each operator automatically logged off if keyboard or mouse activity is not detected within a user-adjustable time. All security data stored in encrypted form.

G. System Diagnostics: System shall automatically monitor the operation of all workstations, printers, modems, network connections, panels, and controllers. Failure of any device annunciated at the workstation.

H. Alarm Processing: Any object in the system shall be configurable to alarm in and out of normal state. Operator able to configure alarm limits, alarm limit differentials, states, and reactions for each object in the system.

I. Alarm Messages: Alarm messages shall use English language descriptors allowing the operator to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.

J. Alarm Reactions: Operator able to set actions to be taken for each alarm. Actions may include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each action configurable by workstation and time of day.

K. Trend Logs: Operator able to define a custom trend log for any data object in the system. Trend definition shall include interval, start time, and stop time. Trend interval shall be selectable as fixed time or Change in value. Trend data sampled and stored on the building controller panel, archived on the workstation hard drive, and retrievable for use in spreadsheets and database programs. System shall be capable of storing 500 sample for each data point.

L. Alarm and Event Log: Provide chronological alarm and event log. Authorized operator able to view alarm and event log from any location in the system and acknowledge and clear alarms. All alarms that have not been cleared shall be archived to the hard drive on the workstation.

M. Object and Property Status and Control: Operator able to view and, if required, edit the status of any object and property in the system.

N. Time clocks in all controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the system. System shall automatically adjust for daylight savings and standard time.

O. Reports and Logs: Provide a reporting package allowing the operator to select, modify, or create reports. Each report definable for data content, format, interval, and date. Report data achievable on the workstation hard drive for historical reporting. System capable of supplying real-time logs of all objects by type or status (e.g. alarm, lockout, normal). Reports and logs stored on the workstation hard drive in a format readily accessible to other standard software applications, including spreadsheets and word processing. Reports and logs readily sent to the system printer by either operator command or automatically by time-of-day. Standard reports shall include:
1. Objects: All system objects and their current value
2. Alarm Summary: All current alarms (except alarms in lockout)
3. Disable Objects: All objects that are disabled or in a manual override state
4. Alarm Lockout Objects: All objects in manual or automatic alarm lockout

5. Alarm Lockout Objects in Alarm: All objects in alarm lockout that are currently in alarm
6. Logs including alarm history, system messages, system events, trends.

P. Remote Communication: Network remote connectivity.

Q. Standard Application Programs:
1. Sequencing: Provide application software to sequence equipment as required by Section 23 09 50.
2. PID Control: Provide a proportional-integral-derivative (PID) algorithm with direct or reverse action and anti-windup to perform modulating control of building equipment as required by Section 23 09 50. Algorithm shall calculate a time-varying analog value to position an output or stage a series of outputs. User-selectable controlled variable, set point, and PID gains.
3. Staggered Start: Provide staggered-start application to prevent all controlled equipment from simultaneously restarting after a power outage. User selectable order-of-equipment restart and time delay between starts.
4. Energy Calculations:
   a. Provide application to allow instantaneous power or flow rates to be accumulated and converted to energy use data.
   b. Provide application to calculate a sliding-window average. User selectable window intervals.
   c. Provide application to calculate a fixed-window average. Initiation of window from digital input signal. User selectable window intervals.
5. Anti-short Cycling: Provide application to prevent any binary output from short cycling. User selectable minimum on-time and off-time.
6. On/off Control with Differential: Provide application allowing a binary output to be cycled based on a controlled variable and set point. User selectable direct or reverse action and differential setpoint.
7. Run-time Totalization: Provide application to totalize run-times for all binary input objects.
8. Time Control Scheduling: Provide application that will start and stop digital and software points according to an adjustable time schedule. Application shall include for basic time schedule, optimum start/stop, special event override, and holiday override.

2.05 WORKSTATION APPLICATION EDITORS

A. General: Provide Workstation Application Editors to edit all applications that reside at system controllers. Applications shall be downloaded and executed at one or more of the controller panels.

B. Controllers: Provide a full-screen editor for each type of application allowing the operator to view and change the configuration, name, control parameters, and set points for all controllers.

C. Scheduling: Provide an editor for the scheduling application. Provide a monthly and weekly calendar for each schedule where scheduling parameters can be changed. Provide a method allowing several objects to follow a schedule with start and stop times for each object adjustable from a master schedule. Schedules shall be easy to copy to other objects and dates.

D. Custom Application Programming: Provide the tools to create, modify, and debug custom application programming. Program creation, modification, or downloading allowed while all other system applications are operating. The programming language shall provide the following features:
1. Provide English language orientation based on BASIC, FORTRAN, C, or PASCAL. Language shall allow free-form programming (i.e. not column-oriented or “fill in the blanks”. Alternately, the programming language can be graphically based using

function blocks if blocks are available to directly provide the functions listed below and custom or compound function blocks can be created.

2. Provide a full-screen character editor. Editor shall be curser/mouse-driven allowing the user to insert, add, modify, and delete custom programming code. Editor shall also support word processing features such as cut/paste and find/replace.
3. Allow development of independently executing program modules with each module able to independently enable or disable other modules.
4. Provide debugging/simulation capability allowing users to step through the program and observe intermediate values and results. Debugger shall provide error messages for syntax and execution errors.
5. Support conditional statements (IF/THEN/ELSE/ELSE-IF) and relations comparisons (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL).
6. Support floating-point arithmetic using operators including plus, minus, divide, times, and square root. The language shall also provide absolute value and minimum/maximum value from a list of values.
7. Provide pre-defined variables representing time of day, day of the week, month of the year, and date. Provide additional variables including elapsed time in seconds, minutes, hours, and days. Elapsed time variable may be reset so that interval-timing functions can be stopped and started within a program. Values from above variables readable so that they can be used in a program for IF/THEN comparisons, calculations, etc.
8. Programming language shall have pre-defined variables representing the status and results of Controller Software and shall be able to enable, disable, and change the setpoints of Controller Software.

2.06 SYSTEM CONTROLLERS

A. First-tier Controllers (Building Controllers): Independent, stand-alone, microprocessor-based controller to manage global control and communication. Provide the number of first-tier controllers needed to meet specified performance requirements. As a minimum, provide one first-tier controller per building. Controllers shall have the following general characteristics.

1. Sufficient memory in each controller to support its operating system, database, and programming requirements including specified spare capacity.
2. Controller operating system to manage input and output communications allowing distributed controllers to share real and virtual object information and allow central monitoring and alarms.
3. Controller shall continually check the status of its processor and memory circuits. If an abnormal condition is detected, the controller shall assume a pre-determined failure mode, and generate an alarm notification.
4. Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
5. Controller shall include a service communication port allowing connection to a portable operator’s terminal.

B. Custom Application Controllers: Independent, stand-alone, microprocessor-based controller to provide local control of systems and equipment requiring custom program sequences. Provide the number of custom application controllers needed to meet specified performance requirements. Controllers shall have the following general characteristics.

1. Sufficient memory in each controller to support its operating system, database, and programming requirements including specified spare capacity.
2. Controller operating system to manage input and output communications allowing distributed controllers to share real and virtual object information and allow central monitoring and alarms.
3. Controller shall continually check the status of its processor and memory circuits. If an abnormal condition is detected, the controller shall assume a pre-determined failure mode, and generate an alarm notification.

4. Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
5. Controller shall include a service communication port allowing connection to a portable operator's terminal.

C. Application Specific Controllers: Independent, stand-alone microprocessor-based controller to control local equipment or systems where the associated sequence of operation can be met using pre-programmed control routines. Controllers should have the following general characteristics.
1. Sufficient memory in each controller to control the target system.
2. Non-volatile memory to maintain the BIOS and programming information in the event of a power failure.

D. Controller hardware suitable for the anticipated ambient conditions.
1. Controllers used outdoors or in wet conditions mounted in NEMA 4 waterproof enclosures rated for operation at –40 degrees F to 150 degrees F.
2. Controllers used in conditioned space mounted in dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.

E. Provide diagnostic LEDs for power, communication, and processor. All wiring connections made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

F. All controllers shall operate at 90% to 110% of nominal voltage and perform an orderly shutdown below 80% nominal voltage. Operation protected against electrical noise at 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

2.07 INPUT/OUTPUT INTERFACE

A. Hardwire inputs and outputs may connect to the system through a first-tier, custom application, or application specific controller.

B. All input and output points protected so that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points protected from connected voltage up to 24V of any duration.

C. Binary Inputs: Binary controller inputs shall provide a wetting current of at least 12 mA and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power application required.

D. Pulse Accumulation Inputs: In addition to standard binary input characteristics, pulse accumulation inputs shall accept up to 10 pulses per second.

E. Analog Inputs: Analog inputs shall allow the monitoring of low-voltage (0 to 10VDC), current (4 to 20 mA), or resistance signals (thermistor or RTD). Analog inputs compatible with commonly available sensing devices.

F. Binary Outputs: Binary outputs to provide on/off control or a pulsed low-voltage signal for pulse-width modulation. Provide three-position (on/off/auto) switch for each output along with indicator light. Output selectable for normally open or normally closed operation.

G. Analog Outputs: Analog outputs to provide a modulating 0 to 10V or 4 to 20 mA signal for control of an end device. Provide two-position (auto/manual) switch, status lights, and manually adjustable potentiometer for each output. Analog output drift less than 0.4% of range per year.

H. Tri-state Outputs: Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point actuators

limited to terminal unit and unit ventilator control applications. Control algorithms shall send the actuator to one end of its stroke every 24 hours for verification of operator tracking.

2.08 WEB INTERFACE

A. General:
1. BAS supplier shall provide web-based access to the system via connection to Owner's Ethernet network connection.
2. Contractor shall provide all communication media, connectors, repeaters, servers, hubs, and routers necessary for network connection. Coordinate with Owner's Authorized Representative.
3. System shall allow simultaneous web interface by up to five independent users without additional licensing or upgrades to hardware or software provided hereunder.
4. User shall not require installation of software on non-workstation computers beyond a current Microsoft or Netscape Navigator browser.

B. Architecture: System may provide web interface through workstation, independent stand-alone Web host, or building controller.

C. Capabilities:
1. System graphics: Provide navigation capability through all system graphics. Provide real time data display of all system point values.
2. View trend graphics: Provide trend information via graphical display. User shall be able to select points to be viewed and set time period and display interval.
3. Alarms: Users shall be able to receive, acknowledge, and silence alarms.
4. Event Log: Users shall be able to view event log.
5. Scheduling: Users shall be able to view and modify equipment operating schedules.

D. Security: Access via the Web browser shall use the same hierarchical security scheme as the BAS. User shall be asked to log in once the browser makes connection to the system, and activity will be limited to those allowed by security limits. After log-in, the system shall record all activity on the event log. Systems shall monitor unsuccessful login attempts. If unsuccessful login attempts exceed Owner-defined setpoint, send alarm message to alarm log and turn off WEB server.

E. Data Export: The system shall be capable of automatically transmitting energy use records to a remote web host provided by the Owner. Data shall be in the form of comma delimited files or other format that can be used to produce energy reports accessible to remote users via web interface.

2.09 POWER SUPPLIES AND LINE FILTERING

A. Provide UL listed control transformers. Provide class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

B. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge suppression shall have the following minimum performance criteria:
1. Dielectric strength of 1,000 volts minimum
2. Response time of 10 nanoseconds
3. Transverse mode noise attenuation of 65 dB or greater
4. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz

2.10 WIRING AND RACEWAYS

A. Provide wiring, plenum cable, and raceways in accordance with Division 26.

B. All insulated wire to have copper conductor. UL labeled for 90-degree C service.

PART 3 – EXECUTION

3.01 COORDINATION

A. Testing and Balancing
1. Provide to the test and balancing contractor a set of all tools necessary to interface to the control system for testing and balancing purposes. Tools to be returned at the completion of test and balancing work.
2. Provide training in the use of the tools.
3. Provide a qualified technician to assist in the test and balancing process where required.

B. Coordinate with controls specified in other sections or divisions. Other sections or divisions include controls and control devices to be part of or interfaced with the control system specified in this section. Integration and coordination with these controls shall be as follows:
1. All communications media and equipment required to interface with equipment specified in other sections provided hereunder unless specifically stated otherwise.
2. Each supplier of a control product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequence of operation stated in Section 23 09 50.
3. Coordinate and resolve any compatibility issues arising between control products provided hereunder and those provided under other sections or divisions.

3.02 WORKMANSHIP

A. Install all equipment in accordance with manufacturers' recommendations.

B. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.

C. Provide sufficient slack and flexible connections in wiring to allow for vibration of piping and equipment.

D. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electric Code.

3.03 ELECTRICAL POWER

A. Provide power for control components as required. Utilize circuits as indicated in Division 26, and at nearest electrical panels. Coordinate with Division 26.

3.04 EXISTING EQUIPMENT

A. Existing Wiring and Tubing:
1. Contractor may reuse existing wiring provided the quality of the existing installation meets this specification. Verify the integrity of existing wiring and re-label in accordance with this specification. Remove wiring abandoned as the result of this work.
2. Remove all pneumatic tubing abandoned as the result of this work.

B. Local Control Panels: Contractor may reuse existing control cabinets to locate new equipment where existing cabinets are in good condition. Remove all redundant equipment within these cabinets. Patch face cover to fill all holes caused by removal of unused equipment.

C. Unless specifically stated elsewhere, Contractor is not responsible for the repair or replacement of existing control system equipment to be reused. Such equipment includes but is not limited to control devices, valves, dampers, or actuators. Should the Contractor

find existing equipment requiring maintenance, Contractor shall notify the Owner immediately. Repair will be performed under separate Contract.

D. Temperature Sensor Wells: Contractor may reuse existing sensor wells in piping. Modify wells as required to provide proper fit of sensors.

E. Starters: Modify existing starter control circuits, if necessary, to provide hand/off/auto control of each starter controlled, as described in Sequence of Operations.

3.05 GENERAL WIRING

A. Provide BAS system power and wiring as required for new and modified controls system components. See Drawings for electrical circuit coordination provided in Construction Documents.

B. All control and interlock wiring shall comply with national and electrical codes and Division 26. Where requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.

C. ALL NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

D. All low-voltage wiring shall meet NEC Class 2 requirements. Low voltage power circuits shall be sub-fused when required to meet Class 2 limits.

E. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling plenum return air plenums, approved cable not in raceway may be used provided cables are UL listed for the intended application.

F. All wiring in mechanical, electrical, or service rooms, wiring located where it may be subject to damage, and wiring exposed in finished spaces shall be installed in raceway.

G. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring may not be used for low-voltage wiring except for the purpose of interfacing the two.

H. Do not install wiring in raceway containing tubing.

I. Where Class 2 wiring is installed exposed, wiring is to be routed parallel or perpendicular to building lines and neatly tied at a maximum of 10-foot intervals.

J. Where plenum cables are used without raceway, support or anchor cable from building structure. Do not anchor or support cable from ductwork, electrical raceways, piping, or suspended ceiling systems.

K. Provide all wire-to-device connections at terminal block or terminal strip. Provide all wire-to-wire connections at terminal block.

L. Neatly bundle wiring located within enclosures to permit access to devices and terminals.

M. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, Contractor shall provide a step-down transformer.

N. All wiring shall be installed as continuous lengths with no splices permitted between termination points.

O. Install plenum wiring in sleeves where it passes through walls and floors. Provide fire-stop foam where necessary to maintain fire rating.

P. Provide size of raceway and size and type of wire as required by NEC and as required to meet manufacturers' recommendations for connected equipment.

Q. Include one pull string in each raceway 1-inch or larger.

R. Use color coded conductors throughout.

S. Locate control and status relays in designated enclosures only. Such enclosures include packaged equipment control cabinets unless such cabinets also contain Class 1 starters.

T. Conceal all raceways except within mechanical, electrical, or service rooms. Maintain minimum raceway clearance of 6-inches from high temperature equipment such as steam piping or boiler flues.

U. Secure raceways with raceway clamps fastened to the structure and spaced in accordance with code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be supported from ductwork, electrical raceways, piping, or suspended ceiling systems.

V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all raceways.

W. Maintain updated wiring diagrams (as-built) at site with terminations identified.

X. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3-feet in length and shall be supported at both ends. Flexible metal raceway less than ½-inch electrical trade size shall not be used. In areas exposed to moisture, including but not limited to chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

Y. No wiring shall be installed in raceway or cable trays used for building communications, fire alarm, or security systems.

3.06 COMMUNICATION WIRING

A. Install in accordance with 3.04 above.

B. Follow manufacturers' recommendations for all communications cabling including but not limited to maximum pulling, tension, and bend radius.

C. Do not install communications cabling in a raceway or enclosure containing Class 1 or other Class 2 wiring.

D. Verify the integrity of the entire network immediately following cable installation using test measures appropriate for each cable.

E. Provide a lightning arrestor between cables and grounds where cable enters or exits a building. Install arrestor in accordance with manufacturers' recommendations.

F. All communications wiring shall be un-spliced length when that length is commercially available.

G. All communications wiring shall be labeled to indicate origination and destination.

H. Ground coaxial cable in accordance with NEC regulations article on "Communications Circuits, Cable and Protector Grounding."

I. One network communication connection will be provided by OSU. Provide Ethernet cabling within facility, as required for controller connections.

3.07 IDENTIFICATION OF HARDWARE AND WIRING

A. Label all wiring and cabling, including wiring and cabling terminating within factory-fabricated panels, within 2 inches of termination with the BAS address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1/2–inch letters on laminated plastic nameplate.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled so that removal of component does not remove label.

E. Identify room sensors relating to terminal box or valves with nameplate located within sensor cover.

F. Arrange components so that UL or CSA labels are visible after equipment is installed.

G. Identifiers shall match record documents.

H. Provide laminated network communication diagrams, point-to-point wiring diagramming, and process control diagrams in each control panel for control components contained therein.

3.08 BAS CONTROLLER INSTALLATION

A. Provide a separate BAS controller for each air handling unit or other discrete system. A BAS controller may control more than one system provided that all points associated with the system are assigned to the same BAS controller. Points used for control loop reset, such as outside air temperature or space temperature, are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type. If input points are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
   1. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of spare points.

C. Provide sufficient internal memory for the specified sequences of operation and trend logging. Provide a minimum of 25% available memory free for future use.

3.09 PROGRAMMING

A. Provide programming for the system as required to perform the sequence of operation. See Section 23 09 50. Provide all other programming necessary for proper operation of the system but not specified including but not limited to time delays, control deadbands, equipment interlocks, equipment sequencing, alarm notification, and control sequences recommended by equipment manufacturers.

B. All control setpoints and loop tuning parameters accessible for review and adjustment at workstation graphics or through workstation menus without requiring modification of program code.

C. For systems using text-based programming, imbed comments in the programming code to clearly describe each section of the program.

D. Contractor to provide time scheduling functions as specified in the Sequence of Operations. Independent schedules shall be provided for each system, unless otherwise specified.

E. Contractor to provide alarming functions as specified in Sequence of Operations. Contractor shall also configure alarming functions as directed by Owner including setting alarm limits and differentials, states, type of notification, and alarm messages.

F. Contractor shall configure trending and functions as directed by Owner including trend data collection and report format.

3.10 GRAPHICS

A. Provide graphics for all controlled systems and floor plans of the building. As a minimum, systems requiring graphics to include each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. On each graphic, show input and output points for the system. Also, show relevant calculated points such as setpoints. Input, output, and software point valves shall be changeable from graphic screen.

B. Show terminal unit information on a “graphic” summary table. Provide dynamic information on each point shown.

3.11 CONTROL SYSTEM CHECKOUT AND TESTING

A. Contractor shall completely test and verify specified control system performance. Compile test results and include with written certification.

B. Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all instruments, controls, and accessory equipment furnished hereunder.

C. Contractor shall perform the following testing and verification.

D. Verify that all control and communications wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
   1. Enable control systems and verify instrument calibration and end-to-end reporting accuracy of all input devices individually. Perform calibration in accordance with manufacturers’ recommendations. Repair or replace all temperature sensors requiring a calibration offset greater than +/- 1^{o}F.
   2. Verify control stability and end-to-end reporting requirements are met.
   3. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that normal positions are correct.
   4. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, start/stop and span are correct, and direction and normal position are correct.
   5. Verify that system operation complies with the sequence of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules.
   6. Tune all BAS control loops and optimum start/stop routines. Control loops shall have stable controlled variable equal to setpoint, and shall maintain stable output signal without cycling. Control loops shall be maintained with in +/- 1^{o}F of setpoint or 2% of input sensor range. Output signal fluctuations shall not exceed 5% during normal operation.
   7. Alarms and Interlocks:
      a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
      b. Trip interlocks using field contacts to check the logic and ensure that the fail-safe condition for all actuators is in the proper direction.
      c. Test interlock actions by simulating alarm conditions to check the initiating value of the variable and the interlock action.

E. Contractor shall maintain the following documentation:
   1. Calibration log including date, time, control system readout, means of verification, verification measurement, and required calibration offset for each analog input.
   2. BAS Loop Response: Supply trend data output in graphical form showing the step response of each BAS loop. The test shall show the loop's response to a change in set point requiring a change in actuator position of at least 25% of full range. Provide sampling rate from 10 seconds to 1 minute depending on loop speed. Trend data shall show for each sample the set point, actuator position, and controlled variable values. Contractor shall retune any loop that indicates unreasonably under-damped or over-damped control.
   3. Demand Limiting: Supply trend data showing the action of any demand limiting functions. Document operation at maximum one-minute intervals for at least 30 minutes.
   4. Operational Logs: Provide operational trend logs for each system indicating set points, operating points, valve positions, mode, and equipment status. Logs shall cover three 48-hour periods and have a sample frequency of not more than 5 minutes. Logs provided in both printed and disk formats.

F. After system operation is completely verified, provide written certification to Owner that systems have been fully tested and are operating according to specifications and ready for functional testing. Provide copies of documentation signed by person performing tests. Documentation to include:
   1. Calibration log
   2. BAS Loop Response Trends
   3. Demand Limiting Trends
   4. Operational Logs

3.12 DEMONSTRATION AND ACCEPTANCE

A. Demonstration: Demonstrate operation of control system to Engineer and Owner including:
   1. Menu functions.
   2. Point overrides.
   3. Control loop response after point modification.
   4. Alarm response time.

3.13 TRAINING

A. Provide a minimum of 24 hours training to Owner's personnel in use and maintenance of BAS building management and control hardware and software. Training shall be provided in two (2) sessions of 8 hours each and two (2) sessions of 4 hours each as follows:
   1. The first session shall provide system overview and training on log on procedures, data access and display, alarm and status descriptions, log requests, execution of commands, and other general system operation procedures.
   2. The second session shall include instruction on system maintenance procedures. Procedures reviewed will include day-to-day system maintenance requirements, calibration techniques and diagnosis of system failures. Diagnosis procedures shall include instructions to follow in the event of failure of each control sub-system or device.
   3. Two remaining sessions shall include instruction on site-specific programs, graphics, and user interfaces.

B. Manufacturers Training: Provide 24-hour manufacturer training course for three Owner's Representatives. Training shall be provided on a variety of topic as selected by the Owner. Training shall be performed at manufacturer's designated locations.

3.14 SOFTWARE

A. Use of Owner's site licenses or operator access rights to BAS is not permitted.

B. Installing firm shall provide required licensing and/or access rights, and portable workstation for system programming, setup, commissioning, and training.

3.15 DESIGN REQUIREMENTS

A. All safety control circuits interlocked with motor starters or VFDs shall be hardwired and shall function in all operating modes (Automatic, Hand, and Manual Bypass).

B. Control setpoints and parameters listed in control sequences are initial values. Adjust setpoints and control parameters as directed by Owner and Engineer to achieve desired environment conditions, optimum system performance, and as recommended by TAB contractor.

C. Control setpoints shall be adjustable from the Operator Workstation without modification of control programming or use of proprietary software. All setpoints which are necessary for normal operation and optimization of system performance as required by Owner shall be adjustable, and shall include, but not be limited to: time schedules; temperature, pressure, humidity, and CO_2 setpoints; time delay settings; safety sequence setpoints; and alarming parameters.

D. Where BAS network communications are provided to networkable control systems or equipment, Contractor shall configure accessible points for control, monitoring, and alarm as required to provide specified sequences and as directed by the Owner's Authorized Representative for trending and monitoring.

E. All cascade control sequences and closed control loops shall have proportional-integral action and derivative capability, except where approved otherwise.

F. Provide BAS alarm functions and configuration as detailed in plans and specifications, and as directed by Owner's Authorized Representative. Alarm functions may include:
1. Visual display on workstation graphic.
2. Audible alarm at workstation computer.
3. Listing in workstation alarm log.
4. "Pop-up" alarm notification at workstation computer.
5. Dial-out alarm to Owner's security staff or alarm monitoring service.

END OF SECTION

SECTION 23 09 30

FIELD INSTALLED CONTROL SYSTEM COMPONENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Temperature Measurement

B. Pressure Measurement

C. Humidity Measurement

D. Electrical Power Measurement

E. Relays and Switches

F. Transducers

G. Automatic Control Valves

H. Actuators

1.02 RELATED SECTION

A. SECTION 23 09 10 – BUILDING AUTOMATION SYSTEM

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Temperature measurement		X						
Pressure measurement			X					
Humidity measurement			X					
Relays and switches		X						
Transducers		X						
Automatic control valves			X	X				
Actuators		X						

1.04 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Control contractor to coordinate with other trades to ensure delivery and correct installation of products furnished but not installed under this section. Coordination to include a review of schedule, manufacturer's installation requirements, and equipment locations. Such products include but are not limited to the following:

1. Control valves
2. Temperature sensor wells and sockets

B. Control contractor to provide all manufacturer's product information including recommended installation instructions to installing Contractor.

PART 2 - PRODUCTS

2.01 TEMPERATURE MEASUREMENT

A. Temperature Sensors
1. Acceptable Manufacturers: Mamac, Precon, Veris, or approved Direct Digital Control System manufacturer. (Mamac and Precon may not make accessories for space temperature sensors needed for the project i.e., set point adjustment, override switch, display, communications port)
2. Sensing element: Thermistor type, +/- 0.5°F from 32°F to 150°F accuracy, less than 0.25°F drift/year. Compatible with BMCS analog input requirements. Select sensor with smallest range available that will span anticipated sensed medium temperature range.
3. Space Air Sensor: Range 40 to 90°F, wall mounted with vandal-resistant heavy plastic or stainless-steel cover. Provide stainless steel cage or other approved enclosure where sensors are susceptible to damage or vandalism.
   a. Options: Provide the following space sensor options.
      1) Local set point adjustment
      2) Override switch
      3) Temperature display
      4) Communications port

B. Temperature Transmitters
1. Acceptable Manufacturer: Mamac, Precon, Veris, or approved Direct Digital Control System manufacturer.
2. Sensing element: 100-ohm, platinum RTD, +/- 0.65°F @ 70°F.
3. Transmitters: 4 to 20 mA output. Select sensor with smallest range available that will span anticipated sensed medium temperature range. NEMA Type 4 rated Instrument head suitable for housing RTD wiring terminations and temperature transmitter and temperature sensor.
4. Outside Air Sensor: Operating range -40 to 140°F, stainless-steel sensor sheath mounted in a weatherproof enclosure.
5. Ductwork Averaging Sensor: Multiple sensing elements contained in soft aluminum tubing. Sensors shall be a minimum of 1 foot in length for every 2 square feet of duct area.
6. Ductwork Probe Sensor: Aluminum or stainless-steel sensor sheath, sensor probe length suitable for application.
7. Well Sensor: Aluminum or stainless-steel sensor sheath, sensor probe length suitable for application. Brass or stainless-steel thermal well rated to 250 psig and 250°F.

2.02 PRESSURE MEASUREMENT

A. Air Pressure Transmitters.
1. Acceptable Manufacturers: Mamac, Setra, Veris
2. Sensor: Solid state, piezoresistive silicon chip pressure.
3. Maximum operating pressure: 200% of design pressure
4. Accuracy: +/- 1% over operating range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Output: 4-20 mA or 0-5 VDC linear.
6. Power Requirement: 24 VAC supply voltage with input power isolation
7. Basis of Design: Mamac model PR-272
8. Accessories:

a. Duct Installation: Provide duct mounted static pressure sensor probe.

B. Outdoor Pressure Sensor (Reference):
1. Acceptable Manufacturer: Paragon or approved.
2. Material: heavy gauge aluminum with hard-anodized finish and 2-inch diameter FPT connection.
3. Construction: Two circular perforated plates with an integral pressure sensing chamber.
4. Measurement: Within 2% of actual value when being subjected to varying wind flows with velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.

C. Filter Pressure Transmitter:
1. Acceptable Manufacturers: Dwyer, Cleveland Draft Gauge, Farr, or approved. Similar to Dwyer series 605 Magnahelic Differential Pressure Indicating Transmitter.
2. Type: Filter differential pressure gauge with manually adjustable signal flag and indicating output signal for BAS monitoring.
3. Accessory bracket for exterior surface mounting.
4. Range: 0 to 1.5 inches, w.g. Control signal output 4-20 mA.

D. Static Pressure Probe
1. Acceptable Manufacturer: Dwyer, Air Monitor, Mamac, or approved Direct Digital Control System manufacturer.
2. General: ¼ brass tubing, 12-inch insertion depth.

2.03 HUMIDITY MEASUREMENT

A. Relative Humidity Transmitter:

B. Acceptable Manufacturer: Mamac, Veris, Vaisala

C. Sensor: Solid state, copolymer wafer sensor. Operating range 0 - 100 RH.

D. Accuracy: +/-2 percent accuracy, temperature compensated.

E. Output: 0-5 VDC, 4/20 mA linear output compatible with BAS manufacturer.

F. Power Supply: 24 VAC supply voltage with input power isolation

G. Basis of Design: Mamac model HU-222.

2.04 RELAYS AND SWITCHES

A. Push Buttons, Position Selector Switches, Manual Operating Switches.
1. General: UL listed, industrial grade

B. Single Phase Motor Control Relays:
1. Acceptable Manufacturer: Greenheck, Veris, or approved.
2. Similar to Veris Hawkeye Model 500 Series.
3. General: Industrial grade load-switching relay, current status switch, and Hand-Off-Auto switch for control or fractional horsepower single phase motors. The relay, current sensor, and HOA switch are combined in a series circuit. Once an H5xx is wired in series between the power source and motor, all three components are installed.
4. Relay: Contacts rated for connected motor load, SPST relay is field-selectable for N.O. or N.C. operation. LED status indicator light.
5. Current Status Switch: Adjustable setpoint.

6. Housing: Surface mounted. The housing provides physical separation and multiple wiring exits to isolate control and high voltage wiring.

C. Current Status Switches for Constant Load Devices, Adjustable Trip
1. Acceptable Manufacturer: Hawkeye or approved equal.
2. Similar to Hawkeye Model 908
3. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
4. Visual LED indicator for status
5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 135 A
6. Normally open current sensor output. 0.1A at 30 VAC/DC

D. Current Status Switches for Variable Frequency Drive Application, Adjustable Trip
1. Acceptable Manufacturer: Hawkeye or approved.
2. Similar to Hawkeye Model H904
3. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
4. Visual LED indicator for status
5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 5 A to 135 A and from 5 to 75 Hz
6. Normally open current sensor output. 0.1A at 30 VAC/DC

E. High Differential Pressure Switch
1. Static pressure/electric relay to detect dirty air filter or fan over-pressure condition. Diaphragm operated contact. Adjustable setpoint range.

F. Low Temperature Limit Switch (Freeze Protection Relay)
1. Low temperature cutout relay. SPDT contact. Adjustable setpoint from 35°F to 50°F.
2. Fixed differential sensing element. Minimum 1 lineal foot of element per 1 square foot of coil area.
3. Automatic reset

G. Pump Pressure Differential Switch
1. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as shown.
2. The differential switches shall meet the following requirements:
   a. Range: 0 to 100 psi.
   b. Differential: 10 psi.
   c. Maximum media temperature: 200°F.
   d. Adjustable differential pressure.
   e. Process connection: 1/4” NPT.
   f. Maximum pressure: 150 psi.
3. Similar to Delta-Pro Model 24-014.

2.05 TRANSDUCERS

A. Analog Electric/Pneumatic Transducer:
1. Acceptable Manufacturer: Mamac, Kele, or approved.
2. Similar to Mamac Model EP-313
3. Rated to a maximum pressure of 40 psig
4. 0 to 20 psi output.
5. Manual override feature. Manual mode switch to control branch line pressure by increase/decrease push buttons.

2.06 AUTOMATIC CONTROL VALVE AND DAMPER ACTUATORS

A. Acceptable Manufacturers: Belimo or approved equal.

B. Proportional Electric Actuator:
1. Direct coupled, spring return. Fully proportioning with ample power to operate valve or damper against fluid pressures and mechanical friction.
2. Size to provide specified valve shut-off pressure or damper differential pressure.
3. 0 to 10 VAC or 4 to 20 mA input control signal.
4. 24 VAC supply power. Suitable for use with Class 2 wiring. Maximum 10 VA for AC installations and 8 watts for DC applications.
5. Actuator shall have electronic overload or digital rotation circuitry to prevent damage to actuator through entire rotation range.
6. Actuators shall initialize when actuator is powered. Initialization will determine stroke length and enable actuator to set minimum and maximum limits of supplied control signal to ensure use of entire control signal range. Feedback automatically adjusted to the effective stroke.
7. Provide manual override and visual position indicator.
8. Provide 2 to 10 VDC position feedback signal corresponding to actual valve or damper position only where indicated on Drawings or in Sequence of Operations.
9. Provide NEMA Type 1 enclosures.
10. Globe Valve Service:
    a. Provide with automatic coupling device locking actuator to valve stem.
11. Damper Service:
    a. Direct shaft-mounted
    b. Provide one actuator per damper section. No connecting rods or jack shafts allowed except where indicated on control drawings.
    c. Provide positive method of attaching actuator to damper shaft. If single bolt or set-screw is used, mill flat side on damper shaft to avoid slippage.

C. Two Position Electric Actuator
1. Direct coupled, spring return or last position as required. Ample power to operate valve or damper against fluid pressures and mechanical friction.
2. Size to provide specified valve shut-off pressure or damper differential pressure.
3. 0 to 24 VAC input control signal.
4. 24 VAC supply power. Suitable for use with Class 2 wiring. Maximum 10 VA for AC installations and 8 watts for DC applications.
5. Actuator shall have electronic overload or digital rotation circuitry to prevent damage to actuator through entire rotation range.
6. Provide manual override and visual position indicator.
7. Provide NEMA Type 1 enclosures.
8. Damper Service
    a. Direct shaft-mounted
    b. Provide one actuator per damper section. No connecting rods or jack shafts allowed except where indicated on control drawings.
    c. Provide positive method of attaching actuator to damper shaft. If single bolt or set-screw is used, mill flat side on damper shaft to avoid slippage.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate field-mounted devices as shown on Drawings and install per manufacturers recommendations.

3.02 SENSORS AND TRANSMITTERS

A. Provide temperature sensor for space temperature sensing applications.

B. Provide temperature transmitter for the following applications:
   1. Outside Air Temperature
   2. Ductwork Temperature with Averaging Sensor
   3. Ductwork Temperature with Probe Sensor
   4. Hydronic System Temperature with Probe Sensor

C. Space Temperature Sensors:
   1. Mount on wall or on ceiling pendant as shown on Drawings.
   2. For wall installation, mount on wall 60 inches above finished floor level in concealed junction boxes properly supported by wall framing.
   3. For ceiling installation, mount on minimum 24-inch pendant, but not less than 84 inches above finished floor level.
   4. Locate space temperature sensor to avoid localized heating or cooling effects from space equipment, lights, or diffusers.
   5. All wires attached to sensors shall be air sealed in their raceways to prevent air transmitted from other areas from affected sensor accuracy.

D. Outside Air Temperature Transmitter:
   1. Mount on north walls
   2. Mount inside ventilated sun shield to minimize radiant energy and wind effects.

E. Ductwork Temperature Transmitters:
   1. Duct mounted sensors duct mounted in electrical box on duct exterior.
   2. For outdoor applications, provide a weatherproof mounting box with weatherproof cover and gasket.

F. Ductwork Averaging Temperature Transmitter: Provide for mixed air applications, ductwork with a cross sectional dimension greater than 48 inches, and any application where non-uniform air temperature exists.

G. Ductwork Probe Temperature Transmitter: Size to position tip of probe in middle of air steam.

H. Hydronic System Temperature Transmitter:
   1. Coordinate with the mechanical contractor to ensure that associated temperature wells are installed where required and located for optimum sensing accuracy.

I. Filter Pressure Transmitter:
   1. At Contractor option, provide new air pressure transmitters or replace existing air filter gauge with gauge pressure transmitter. Field mount filter gauge be on the filter access side piped with copper tubing around filter bank, where indicated on Drawings.

3.03 SPACE HUMIDITY SENSOR

A. Mount on wall or on ceiling pendant as shown on Drawings. Mount on wall 60 inches above finished floor level. Mount on 24-inch pendant, but not less than 84 inches above finished floor level.

3.04 RELAYS AND SWITCHES

A. Current Status Switches:
   1. Provide current status switch to monitor status of all motor-driven equipment where status is required.
   2. Wrap power conductor through current transformer multiple times to amplify current signal where required.

3. Provide enclosure adjacent to existing motor starter when space in starter is not adequate to house current status switch.

B. Low Temperature Limit Switches:
   1. Sensors elements shall be installed to protect entire face of coils
   2. To allow testing, install with 12-inch loop of sensing element outside of fan housing. Not applicable for outdoor installations.

3.05 TRANSDUCERS

A. Locate transducer adjacent to control panel. Ensure manual override switch is easily accessible by operator.

3.06 AUTOMATIC DAMPER ACTUATORS

A. Provide a minimum of one damper actuator per damper section.

3.07 AUTOMATIC VALVES

A. Install all slip-stem control valves with stem position no more than 60 degrees from vertical.

B. Locate to allow access and service. Ensure that actuator can be removed and services without interference from structure of other piping and equipment.

C. Contractor shall verify that control valve port arrangement provides the intended valve function when installed as shown on Drawings. Notify Owner's Authorized Representative and Engineer of any potential conflict between the installation plans and control valve installation requirements prior to start of associated work. Any control valves installed with incorrect connections will be re-piped to provide correct operation at no expense to the Owner.

3.08 ACTUATORS

A. Damper actuators shall not be installed in the air stream unless specified shown on Drawings.

B. Provide weather shield where actuators are mounted outside of conditioned space.

C. Provide air gaps, thermal isolation washers or spacers, standoff legs, or insulation if required to ensure that actuator ambient temperature does not exceed actuator rating.

D. Actuator cords or conduit shall incorporate a drip leg if condensation is possible.

END OF SECTION

SECTION 23 09 50

AUTOMATIC CONTROLS SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Description of Control Sequences.

1.02 WORK INCLUDED

A. The control system will consist of all necessary devices and software to provide the sequences of operation described herein.

B. Provide custom engineered BAS operating software to perform control sequences specified. Sequence of operations describes major control functions but does not limit Contractor's responsibility to provide a fully operational automatic control system. Contractor shall provide additional control functions not specifically described herein including time delays, control deadbands, equipment interlocks, equipment sequencing, alarm notification, control functions recommended by equipment manufacturers, or as otherwise required.

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirements listed herein.
9.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products This Section								X

B. Special Requirements: Provide a complete written sequence of operations for each system or subsystem under all modes of operation. Where Contractor proposes any variation to the sequence of operation described hereunder, the Contractor shall specifically highlight the change and describe the reason for the revision.

1.04 DESIGN REQUIREMENTS

A. All safety control circuits interlocked with motor starters or VFDs shall be hardwired and shall function in all operating modes (Automatic, Hand, and Manual Bypass).

B. Control setpoints and parameters listed in control sequences are initial values. Adjust setpoints and control parameters as directed by Owner and Engineer to achieve desired environment conditions, optimum system performance, and as recommended by TAB contractor.

C. Control setpoints shall be adjustable from the operator workstation without modification of control programming or use of proprietary software. All setpoints which are necessary for normal operation and optimization of system performance as required by Owner shall be adjustable, and shall include, but not be limited to: time schedules; temperature, and pressure; time delay settings; safety sequence setpoints; and alarming parameters.

D. Where BAS network communications are provided to networkable control systems or equipment, Contractor shall configure accessible points for control, monitoring, and alarm as required to provide specified sequences and as directed by the Owner's Authorized Representative for trending and monitoring.

E. All cascade control sequences and closed control loops shall have proportional-integral action and derivative capability, except where approved otherwise.

F. Provide BAS alarm functions and configuration as detailed in plans and specifications, and as directed by Owner's Authorized Representative. Alarm functions may include:
1. Visual display on workstation graphic.
2. Audible alarm at workstation computer.
3. Listing in workstation alarm log.
4. "Pop-up" alarm notification at workstation computer.
5. Dial-out alarm to Owner's security staff or alarm monitoring service.

PART 2 - PRODUCTS

2.01 HEATING WATER SYSTEM

A. General: Building heating water produced by constant flow, primary only, heating water system with one steam to hot water heat exchanger, and multiple zone heating water pumps operating in parallel.

B. Pump Motor Control: Operate subject to new Hand-Off-Auto switch at existing motor starter. Verify that safety control sequences are enabled through each switch position.

C. Period of Operation:
1. Enable heating water system when any of the following conditions occur:
   a. Outside air temperature is below 60°F and any air handling system is enabled.
2. Disable heating water system when any of the following conditions occur:
   a. Outside air temperature is above 68°F.

D. Pump Control:
1. Start each zone pump whenever the heating water system is enabled.
2. Pumps operate with a minimum 10 minutes runtime if started, and for 10 minutes after heating water system is disabled.

E. Steam Heat Exchanger Temperature Control:
1. Heating water system enabled:
   a. Modulate steam control valve to maintain heating water supply temperature setpoint. Use a reset schedule to vary the supply water temperature from a maximum of 180ºF at 25ºF outside air to a minimum of 120ºF at 65ºF outside air.
2. High temperature alarm: If discharge heating water is above 200°F, activate alarm. Maintain alarm until acknowledged by operator.
3. Heating Water System Disabled: Close steam control valve.

F. Safety Controls: Override normal operating modes whenever the following emergency conditions occur.
1. Heating Water System Failure: If the heating water supply temperature is more than 10°F below setpoint for more than 10 minutes, activate Critical Heating Water System Alarm. Maintain alarm until acknowledged by operator. Activate alarm timer 30 minutes after heating water system start-up to allow for system warm-up.
2. Pump Status: If a motor is commanded "on" and the motor status after a 20 second delay indicates that the motor is off, activate status alarm. Maintain alarm until acknowledged by building operator.

G. Input/Output Points List

1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points listed below. Where BAS points are obtained from packaged equipment, the equipment connection is listed following the point description.

BAS Points List	Equipment Connection
Digital Inputs	
South Radiation Pump status	
East Radiation pump status	
Digital Outputs	
South Radiation Pump start/stop	
East Radiation pump start/stop	
Analog Inputs	
Heating water supply temperature	
Heating water return temperature	
Analog Outputs	
Steam control valve	

2.02 CHILLED WATER SYSTEM, CH-1 & CWP-1

A. System Description: Existing constant volume primary chilled water system with one air-cooled water chiller. Pump is controlled through boiler control panel. Chiller system is enabled by BAS. Provide current status switch for existing pump. Chiller water temperature control is maintained by packaged chiller controls.

B. Chiller System Enable:
1. On command from BAS chiller system is enabled, at 60°F outside temperature. Chiller disabled when outside temperature is below 60°F.
2. Start chilled water pump, CWP-1 from chiller contacts. Once chiller is enabled, minimum operational period is 30 minutes.
3. Packaged chiller control system to maintain supply water temperature setpoint.
4. Reset chilled water supply temperature setpoint subject to outside air temperature. Initial setpoints shall be 50°F at 60°F and 45°F at 85°F and above.

C. Input/Output Points List
1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points listed below. Where points are obtained from packaged equipment, the equipment connection is listed following the point description.

BAS POINTS LIST	EQUIPMENT CONNECTION
Digital Inputs	
Chilled Water System status	
Chiller System Alarm	
CWP-1 Status	
CWP-2 Status	
Glycol tank low limit	
Digital Outputs	
Chilled Water System Enable/disable	
Analog Inputs	

Outside Air Temperature	
Chilled Water Supply Temperature	
Chilled Water Return Temperature	
Analog Outputs	
Chilled Water Temperature Setpoint	

2.03 CONDENSER/PROCESS COOLING WATER SYSTEM, CT-1, CDP-1

A. Condenser Water Pump Operation: Pumps operate subject to individual on-off-auto switch at motor VFDs as follows.
   1. Auto Position: Operate pumps subject to BAS control sequences and hardwired safety control interlocks.
   2. On Position: Override automatic BAS control sequences and start pump. Operate pumps subject to hardwired safety control interlocks.
   3. Off Position: Pump off.

B. Condenser Water Pump Control:
   1. CDP-1: Pump operates continuously for cold room condensing units. Each condensing unit water connection contains self-contained thermostatic controls to maintain entering supply water temperature.

C. Condenser Water Supply Temperature Control, Cooling Tower, CT-1, by-pass valve:
   1. Condenser water system enabled prior to chilled water system enable.
   2. Cooling Tower, CT-1:
      a. Following condenser water enable, CT-1 operate fan at fixed 75% fan speed to maintain condenser water temperature between 65°F (adj.) and 78°F (adj.)
      b. Low temperature limit – When condenser water supply temperature is 67°F (adj.), modulate fan speed from 75% to 20% to maintain 65°F.
      c. High temperature limit – When condenser water supply temperature is 78°F, modulate fan speed from 75% to 100% (adj.) to maintain 80°F.

D. Alarm Monitoring and Control
   1. Condenser Water High Temperature Alarm
   2. Condenser water pump failure
   3. Cooling tower fan failure
   4. Tower basin temperature:
      a. Basin water temperature below 40°F.

E. Input/Output Points List
   1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points listed below. Where BAS points are obtained from packaged equipment, the equipment connection is listed following the point description.

BAS Points List	Equipment Connection
Digital Inputs	
Cooling Tower Fan Status	
Pump CDP-1 Status	
Digital Outputs	
Pump CDP-1 start/stop	
CT-1 fan start/stop	VFD
Analog Inputs	

Condenser Supply Water Temperature	
Condenser Return Water Temperature	
Cooling Tower, CT-1 basin water temperature	Cooling tower sump
Analog Outputs	
Cooling tower, CT-1, fan speed	VFD
Condenser water bypass valve	
BacNet Communications	
Cooling Tower, CT-1 Fan	VFD

2.04 AIR HANDLING UNIT RADIATION CENTER ASU-1

A. General: ASU-1 is an existing 100% outside air, constant volume, multizone air handling units equipped with two supply fans, steam pre-heating coil, chilled water cooling coil and outside dampers. Zone duct heating coils are located in air handler supply plenum.

B. Motor Controls: Fan to operate subject to individual on-off-auto switch at motor control device as follows.
   1. Auto Position: Operate fan motors subject to BAS automatic control sequence.
   2. On Position: Start fan motors subject to Safety Control and Alarm sequences.
   3. Off Position: Stop fan motors. Set systems to unoccupied configuration.

C. Mode Control:
   1. Provide time schedule to define occupied/unoccupied times for each day of the week and holidays.
   2. Occupied Mode: Enabled during scheduled occupied hours.
   3. Warm-up Mode: Warm-up mode enabled by optimized start routine for period immediately prior to occupied mode. Optimized start routine will have the following elements.
      a. Control length of warm-up period so that the lowest space temperature is at the occupied period heating setpoint at the scheduled occupancy time.
      b. Limit start time to a maximum of two hours prior to the occupied start time.
      c. The optimal start sequence shall use the lowest space temperature and outside air temperature to calculate an estimated start time.
      d. The optimal start sequence will only be enabled if the outside air temperature is below 60°F.
      e. Configure the control sequence so the optimal start sequence mode can be overridden for each individual air handling system or globally for all air handling systems in the building.
   4. Night Low Limit Mode: Enabled during unoccupied mode if any space temperature is below 55°F. Disable when all space temperatures are above 60°F.
   5. Night High Limit Mode: Enabled during unoccupied mode if any space temperature is above 85°F. Disable when all space temperatures reach 80°F.
   6. Unoccupied Mode: Enabled during unoccupied hours when Occupied and Warm-up modes are not enabled.

D. Occupied Mode:
   1. Open outside air damper.
   2. Supply Fan: Fans on.
   3. Supply Air Temperature Control: Modulate heating and cooling coil valves in sequence to maintain discharge air the temperature setpoint.
   4. Each valve closed when not in respective heating or cooling operation.

E. Discharge Temperature Setpoint
   1. Reset temperature setpoint between 55°F and 70°F, based on average zone cooling demand.

F. Night Low Limit
   1. Open outside air damper.
   2. Supply Fan: Fans on.
   3. Supply Air Temperature Control:
      a. Modulate pre-heating coil valves in sequence to maintain 70°F discharge air the temperature.
      b. Modulate zone coil valves to maintain 85°F supply air temperature

G. Unoccupied Mode:
   1. Supply fans off.
   2. Outside air damper closed.
   3. Chilled water coil valves closed.
   4. Zone heating coil valves closed.

H. Zone Temperature Control:
   1. Occupied Mode Control (Temperature Control Only):
      a. Cooling Mode: Zone valve closed.
      b. Heating Mode: Modulate steam coil control valve to maintain space temperature setpoint.
   2. Unoccupied Period Control: Close steam coil valve.

I. Zone Temperature Control, Reactor Building Zone Duct, ASV-11:
   1. Occupied Mode Control (Temperature Control Only):
      a. Cooling Mode: Zone valve closed.
      b. Heating Mode: Modulate steam coil control valve to maintain supply air temperature to 65°F (adj.). Modulate individual duct coil control valves to maintain space temperature setpoints.
   2. Unoccupied Period Control: Close steam coil valves.

J. Safety Control and Alarm
   1. Radiation detection Emergency Shutdown: Upon existing signal input, shut down air handling system.
   2. High Discharge Pressure: Hard wire a high-pressure switch between the fan discharge and the hot and cold duct dampers. Stop fan if high pressure setting is exceeded, and provide alarm. Maintain alarm until acknowledged by operator.
   3. Low Return Pressure: Hard wire a low-pressure switch between the outside dampers and supply fans intake. Stop fans if low pressure setting is exceeded, and provide alarm. Maintain alarm until acknowledged by operator.
   4. Filter change indication: Activate separate alarms for each of the pre and final filters when pre-determined final pressure is indicated. Provide filter change alarm if filter pressure drop exceeds 0.75 inches w.c.
   5. Low Discharge Temperature Alarm: Activate alarm if the hot duct discharge air temperature is below 50°F. Fans remain on. Maintain alarm until acknowledged by operator.
   6. Fan Alarm Mode: If either fan is commanded "on" and the associated fan status after a 30 second delay indicates that a fan is off, provide a critical alarm. Maintain alarm until acknowledged by operator.
   7. Freeze Protection (hardware): Activate freeze protection alarm when supply temperature is less than 36ºF. Stop supply and exhaust fans. Associated valves and dampers set to unoccupied mode position, except modulate preheat coil control valve to maintain leaving air temperature of 60ºF. Electrically interlock to fan starter. BAS to automatic restart when alarm status is normal. Maintain alarm until acknowledged by building operator.

K. Input/Output Points List
   1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points as follows:

BAS Points List	Equipment Connection

Digital Inputs	
Supply fan SF-1 status	
Supply fan SF-2 status	
Radiation Detection Emergency Shutdown	Existing signal from Reactor Building JCI Control Panel
Freeze protection switch	
Supply fan low pressure switch	
OSA damper open/closed position feedback	
Digital Outputs	
Supply fan SF-1 start/stop	VFD
Supply fan SF-2 start/stop	VFD
Outside air damper open/closed	
Analog Inputs	
Outside air temperature	
Supply air temperature, supply plenum	
Pre-filter pressure drop	
Final filter pressure drop	
Supply fan, SF-1 airflow	
Supply fan, SF-2 airflow	
Building space pressure – reference	
Building space humidity #1- reference	
Building space humidity #2 - reference	
Discharge air temperature, each zone duct, typical of 10	
Discharge air temperature, each Reactor Building duct coil, typical of four	
Zone temperature, each zone, typical of 14	
Analog Outputs	
Supply fan SF-1 speed	VFD
Supply fan SF-2 speed	VFD
Pre-heat coil control valve ASV-1	
Pre-heat coil control valve ASV-2	
Cooling coil control valve #1	
Cooling coil control valve #2	
Zone coil valves ASV-3 through ASV-10, ASV-12	
Zone coil valves ASV-11 (Reactor Primary Zone)	
Zone coil valves ASV-18 through ASV-21	

2.05 PERIMETER RADIATORS/CONVECTORS

A. General: 2-pipe radiant heaters.

B. Space Temperature Control:
1. Warm-up and Occupied Modes: Modulate heating control valve to maintain space heating setpoint of 68ºF.
2. Unoccupied Mode: Modulate heating control valve to maintain space heating setpoint of 60ºF.

C. Input/Output Points List
1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points listed below and as shown on Drawings.

Where BAS points are obtained from packaged equipment, the equipment connection is listed following the point description.

BAS Points List	Equipment Connection
Analog Inputs	
Room space temperature, each zone	
Analog Outputs	
Heating water control valve, AWV	

2.06 UNIT HEATERS

A. Space Temperature Control: Start unit heater fan and open heating water control valve when space temperature is below 60°F, UH-3, 45°F. For spaces with multiple unit heaters, control heating water valves and fans in unison.

1. Input/Output Points List

a. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points listed below. Where BAS points are obtained from packaged equipment, the equipment connection is listed following the point description.

BAS Points List	Point Communication	Point Source
Digital Outputs		
Fan start/stop		
Heating water control valves ASV-13 through ASV-15		
Analog Inputs		
Space temperatures, each zone		

2.07 EXHAUST FANS

A. General: Exhaust fans interlocked with AHU to operate continuously when air handler supply fans are operating.

B. Safety Control:

1. Fan Status: If a motor is commanded “on” and the motor status after a 30 second delay indicates that the motor is off, activate status alarm. Maintain alarm until acknowledged by building operator.

C. Input/Output Points List

1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points as scheduled on Drawings.

2.

BAS Points List	Equipment Connection
Digital Inputs	
EF-1 fan status	
EF-2 fan status	
Digital Outputs	
EF-1 fan start/stop	
EF-2 fan start/stop	

2.08 EQUIPMENT AND SYSTEMS MONITORING

A. Provide monitoring and alarms for the following systems and conditions:
   1. Compressed air: Alarm on low compressed air pressure
   2. Sump pump high water alarm – typical of two.
   3. Lab vacuum piping: High lab vacuum system pressure

B. Input/Output Points List
   1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points as scheduled on Drawings.

2.09 LAB EXHAUST FANS

A. Existing lab exhaust fans not included in sequences and points lists will not be incorporated into automatic controls.

2.10 REACTOR BUILDING ASU-1

A. General: ASU-1 (same tag as Radiation Center Unit) is an existing 100% outside air, constant volume, non-recirculating single zone air handling unit equipped with supply fan, steam pre-heating and heating coils, and outside damper.

B. Motor Controls: Fan to operate subject to individual on-off-auto switch at motor control device as follows.
   1. Auto Position: Operate fan motors subject to BAS automatic control sequence.
   2. On Position: Start fan motors subject to Safety Control and Alarm sequences.
   3. Off Position: Stop fan motors. Set systems to unoccupied configuration.

C. Mode Control:
   1. Provide time schedule to define occupied/unoccupied times for each day of the week and holidays.
   2. Occupied Mode: Enabled during scheduled occupied hours.
   3. Warm-up Mode: Warm-up mode enabled by optimized start routine for period immediately prior to occupied mode. Optimized start routine will have the following elements.
      a. Control length of warm-up period so that the lowest space temperature is at the occupied period heating setpoint at the scheduled occupancy time.
      b. Limit start time to a maximum of two hours prior to the occupied start time.
      c. The optimal start sequence shall use the lowest space temperature and outside air temperature to calculate an estimated start time.
      d. The optimal start sequence will only be enabled if the outside air temperature is below 60°F.
      e. Configure the control sequence so the optimal start sequence mode can be overridden for each individual air handling system or globally for all air handling systems in the building.
   4. Night Low Limit Mode: Enabled during unoccupied mode if any space temperature is below 55°F. Disable when all space temperatures are above 60°F.
   5. Unoccupied Mode: Enabled during unoccupied hours when Occupied and Warm-up modes are not enabled.

D. Occupied Mode:
   1. Open outside air damper.
   2. Supply Fan: Fans on.
   3. Supply Air Temperature Control: Modulate heating and cooling coil valves in sequence to maintain discharge air the temperature setpoint.
   4. Each valve closed when not in respective heating or cooling operation.

E. Discharge Temperature Setpoint
   1. Reset temperature setpoint between 55°F and 70°F, based on average zone cooling demand.

F. Night Low Limit
1. Match Occupied Mode control sequences.

G. Unoccupied Mode:
1. Match Occupied Mode control sequences.

H. Safety Control and Alarm
1. High Discharge Pressure: Hard wire a high-pressure switch between the fan discharge and the hot and cold duct dampers. Stop fan if high pressure setting is exceeded, and provide alarm. Maintain alarm until acknowledged by operator.
2. Low Return Pressure: Hard wire a low-pressure switch between the return and outside dampers and return fan intake. Stop fans if low pressure setting is exceeded, and provide alarm. Maintain alarm until acknowledged by operator.
3. Filter change indication: Activate separate alarms for each the pre and final filters when pre-determined final pressure is indicated.
4. Low Discharge Temperature Alarm: Activate alarm if the hot duct discharge air temperature is below 50°F. Fans remain on. Maintain alarm until acknowledged by operator.
5. Fan Alarm Mode: If either fan is commanded "on" and the associated fan status after a 30 second delay indicates that a fan is off, provide a critical alarm. Maintain alarm until acknowledged by operator.
6. Freeze Protection (hardware): Activate freeze protection alarm when supply temperature is less than 36ºF. Stop supply and exhaust fans. Associated valves and dampers set to unoccupied mode position, except modulate preheat coil control valve to maintain leaving air temperature of 60ºF. Electrically interlock to fan starter. BAS to automatic restart when alarm status is normal. Maintain alarm until acknowledged by building operator.
7. Filter Alarm: Provide filter change alarm if filter pressure drop exceeds 0.75 inches w.c.

I. Input/Output Points List
1. Provide all control points required to perform the automatic control sequence described above, which as a minimum shall include all points as follows:

BAS Points List	Equipment Connection
Digital Inputs	
Supply fan status	
Freeze protection switch	
Supply fan low pressure switch	
Digital Outputs	
Supply fan start/stop	
Outside air damper open/closed	
Analog Inputs	
Outside air temperature	
Supply air temperature	
Pre-filter pressure drop	
Reactor Room Space Temperature	
Analog Outputs	
Pre-heat coil control valve, ASV-16	
Heating coil control valve, ASV-17	

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install complete control system including all components, devices, and accessories required to perform listed sequences of operation.

END OF SECTION

SECTION 23 21 16

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes special-duty valves and specialties for hydronic piping applications.

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Hydronic Specialty Valves		X						X
Balancing Devices	X		X	X			X	
Air Control Devices		X						
Expansion Tanks		X		X				
Strainers		X						
Connectors			X					
Buffer Tanks			X			X		
Testing and Monitoring Devices		X						

B. Special Requirements
1. Hydronic Specialty Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Balancing Devices: Provide instrument schedule listing each balancing device furnished along with model number, line size, design flow, permanent pressure drop, and measurement differential pressure at design flow.
3. Flexible Spherical Expansion Joints: Provide written verification from supplier that control rods have been provided where the manufacturer determines the installation exceeds the pressure requirement without control rods.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 HYDRONIC SPECIALTY VALVES

A. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Bell & Gossett; a Xylem brand.
   b. Cash-Acme Watts
   c. Wilkins
2. Body:
   a. 2-1/2 inch and Smaller: Brass body, screwed.
   b. 3-inch and Larger: Iron body, flanged.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Stainless-steel
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Same size as makeup water piping or as shown on Drawings. Operating pressure and capacity factory set and field adjustable.
11. Pressure rating: 300 psi.
12. Temperature rating: 160°F.

B. Diaphragm-Operated Safety Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Bell & Gossett; a Xylem brand.
   b. Cash-Acme.
   c. Wilkins.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.02 BALANCING DEVICES

A. Flow Measuring Station:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Grinnell Mechanical Products.
   c. Tour & Andersson; available through Victaulic Company.
   d. Macon Balancing.
2. Body:
   a. 2-inch and Smaller: Bronze construction, threaded connection.
   b. 2-1/2 inch and Larger: Cast-iron, flanged connection.
3. Disc: Bronze
4. Seat: Teflon or resin.
5. Pressure Gage Connections: Integral quick connection test ports located upstream and downstream of valve seat for portable differential pressure meter.

6. Handle Style: Hand wheel with vernier valve position scale and hidden memory stops.
7. CWP Rating: Minimum 125 psig.
8. Maximum Operating Temperature: 250°F.
9. Size: Line size unless device pressure drop does not conform to the following requirements then provide nearest conforming size.
    a. Full open pressure drop shall not exceed 3 feet water column at design flow.
    b. Minimum position (0.5 turn) pressure drop shall not be less than 3 feet water column at design flow.
10. Accessories: Preformed insulation jacket, ASTM 1784.

B. Venturi Flow Meter:
1. Acceptable Manufacturer: Armstrong, Tour Anderson, Macon Balancing, or approved.
2. Venturi flow measuring device with built-in sensing taps, nipples, shut-off valves, quick connect couplings, and identification tag showing size, design, flow rate, and pressure difference. One-piece cadmium plated, cast-iron steel, flanged ends.
3. Size In accordance with manufacturers' recommendations. Permanent pressure drop shall not exceed 3 feet water column.

2.03 AIR-CONTROL DEVICES

A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett; a Xylem brand.
    d. Nexus Valve, 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: 225F.

B. Automatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AMTROL, Inc.
    b. Bell & Gossett; a Xylem brand.
    c. Spirotherm, Inc.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240°F.

C. Coalescing-Type Air Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by the following: Spirotherm, Taco, Wessels, or approved. Similar to Taco 4900 series.
2. Tank: Fabricated steel tank; ASME constructed and stamped for 150-psig working pressure and 270°F maximum operating temperature.
3. Coalescing Medium: Copper or stainless-steel.
4. Air Removal: Venting chamber to prevent system contaminants from harming float and venting valve operation. Integral full port float actuated brass venting mechanism

at the top of the venting chamber. Valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
5. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded to the bottom of the separator.
7. Size: Match system flow capacity.

2.04 EXPANSION TANKS

A. Bladder-Type Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: AMTROL, Inc., Bell & Gossett; a Xylem brand, Taco, Wessels, or approved.
2. Tank: Vertical welded steel, rated for 125-psig working pressure and 375°F maximum operating temperature. Factory test after taps are fabricated and supports installed. Labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Galvanized or epoxy coated.
3. Bladder: Butyl rubber. Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. Bladder tanks larger than 50 gallons shall have full acceptance bladder design.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Capacity: As scheduled on Drawings.

2.05 STRAINERS

A. Y-Pattern Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong.
   b. Mueller Steam Specialty.
   c. Spirax Sarco,
   d. Watts.
2. Body: Bolted cover and threaded bottom blowoff outlet connection.
   a. Steel Piping System: ASTM A 126, Class B, cast iron.
   b. Copper Piping Systems: Bronze
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Screen:
   a. Free area of strainer element no less than four times the pipe cross sectional area.
   b. Material
      1) Closed, chemically treated hydronic systems: Stainless-steel.
      2) Open or non-chemically treated hydronic systems: Brass
   c. Size
      1) 2-inch and Smaller: 20 mesh
      2) 2-1/2 inch to 4-inch: 1/16-inch perforations
      3) 5-inch and Larger: 1/8-inch perforations.
5. CWP Rating: 125 psig.

2.06 CONNECTORS

A. Flexible Spherical Connectors
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kinetics Noise Control, Inc.
   b. Mason Industries, Inc.
2. Basis of Design: Mason Industries Safelex SFDEJ, SFEJ, SFDCR, or SFU with CR control rods.
3. Construction:
   a. Peroxide cured EPDM in the covers, liners and Kevlar tire cord.

b. Solid steel rings used within the raised face rubber ends to prevent pullout.
c. Rating: Rated at 250 psi up to 170°F with a uniform drop in allowable pressure to 215 psi at 250°F.
d. Configuration
1) Sizes 2" and larger Sizes 2-inch and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges split ductile iron or steel with hooked or similar interlocks.
2) Sizes ¾-inch to 1-1/2-inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
e. Control Rods: Provide control rods at unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods. Where control rods are used, provide 1/2" thick neoprene washer bushings large enough to withstand thrust at loads at 1000 psi maximum on the washer area.

B. Flexible Stainless Steel or Copper/Bronze Hose Connectors
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
2. Basis of Design:
a. 2-inch and Smaller: Mason Industries MN or CPS Series
b. 2-1/2 inch and Larger: Mason Industries FFL or CPS Series
3. Construction:
a. Steel Piping Systems: Stainless steel braid and carbon steel fittings.
b. Copper Piping Systems: Braided bronze hose with copper ends.
4. Minimum Face to Face Length:
a. 2-inch and smaller, 24 inches
b. 2-1/2 inch and larger, 36 inches.
5. Connection
a. Steel
1) 2-inch and Smaller: Male nipple.
2) 2-1/2 inch and Larger: Flanged hoses with one fixed and one floating raised face carbon steel plate flange
b. Copper: Sweat connection

2.07 BUFFER TANKS

A. Acceptable Manufacturer: Taco, Laars, Cemline Corporation or approved. Similar to Taco BHH Series.

B. General: Carbon steel tank. ASME code constructed and stamped for 125 psi maximum pressure. Registered with the National Board of Boiler and Pressure Valve Inspectors. Tanks larger than 42-inches in diameter furnished with a 12-inch x 16-inch manhole.

C. Accessories:
1. Air vent.

D. Capacity/Size: As scheduled on Drawings.

2.08 TESTING AND MONITORING

A. Test Plugs
1. Acceptable Manufacturers: Sisco P/T Plugs, Pete's Plug, Waymire, or approved.
2. Description:
a. Body: ¼-inch NPT, solid brass, 1/8-inch probe diameter
b. Seal: Nordel for maximum 275°F service
c. Cap: Cap with gasket when not in use
d. Rating: 500 psig

B. Site Flow Indications
1. Acceptable Manufacturers: John Ernst, Model 137P.
2. General: Double window indicator for direct visual inspection of liquid.
3. Indicator Wheel: No.
4. Body: Bronze
5. Rating: 125 psi at 200°F.

PART 3 - EXECUTION

3.01 HYDRONIC SPECIALTIES INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

B. Pressure Reducing Valve: Locate in piping where shown on Drawings. Provide strainer upstream of pressure reducing valve and union on each side. Provide isolation valves and bypass piping with bypass valve. Provide downstream pressure gauge.

C. Safety Relief Valve: Install where shown on Drawings. Pipe to nearest drain. Provide pressure relief setting shown on Drawings.

D. Balancing Devices:
1. Install in piping where shown on Drawings. Install with minimum lengths of straight upstream and downstream pipe without valves or fittings in accordance with manufacturer's recommendations. Piping in straight upstream and downstream sections to be same size as balancing device connection.
2. Install so temperature and pressure probes can easily be inserted and removed.

E. Air Vents
1. Install automatic air vents and associated drain piping to floor drain or floor sink at the following locations.
a. Air separator vent connection.
b. High points in mechanical rooms.
c. Top of each floor piping risers.
2. Install manual air vents at all other high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

F. Air Separator
1. Provide suitable support for separator. Do not support from adjacent piping.

G. Expansion Tanks
1. Install tank fittings that are shipped loose.
2. Install expansion tanks on the floor. Vent and purge air from hydronic system and ensure that tank is properly charged with air to suit system Project requirements.

H. Y-Pattern Strainers
1. Locate where shown on Drawings and ahead of reducing valves, automatic control valves, and pumps.
2. Arrange for easy access.
3. Provide ball valve with hose end connection on blowoff outlet of hydronic system strainers two inches and larger.
4. Provide globe valve on blowoff outlet of steam system strainers.
5. Provide pressure gauges on strainers 4-inch and larger. Pipe to strainer inlet and outlet. Provide ball valve at each connection.

I. Connectors
1. For flexible spherical expansion joints, verify control rods are provided where required to address system operating pressure and pipe anchorage limitations.
2. Install with no misalignment of piping and equipment connections.

J. Test Plugs
   1. Location:
      a. Provide where shown on Drawings.
      b. Provide immediately adjacent to each control system component that senses temperature or pressure. For differential pressure transmitters, provide test plug adjacent to both high pressure and low-pressure sensing ports.
   2. Arrangement
      a. Install so temperature probe and pressure gauge probe can easily be inserted and removed with no obstruction.
      b. Install so temperature and pressure gauges can easily be read.

3.02 ADJUSTMENT

A. Pressure Reducing Valve: Adjust make-up water pressure setpoint to value shown on Drawings or as directed by Engineer.

B. Expansion Tank: Adjust tank charge pressure to the system make-up pressure setpoint plus 2 psig. Adjust for elevation differences between the expansion tank and make-up pressure regulator.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. In-line centrifugal pumps

1.02 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.03 QUALITY ASSURANCE

A. Pump and motor combination shall operate at specified system fluid temperatures without vapor binding or cavitation and are non-overloading in parallel or individual operation.

B. Pumps shall conform to ANSI/HI 9.6.1-1997 standards for Centrifugal and Vertical Pumps for NPSH Margin.

C. Pump impeller diameter shall not exceed 90% of maximum impeller diameter.

D. If equipment is approved which has different flow or pressure drop requirements than scheduled, contractor shall select new pumps with capacity and pressure capabilities adjusted to maintain scheduled pump efficiency and requirements. Select pumps so that the head-capacity curve slopes up to maximum pressure at shut-off. Contractor will provide all additional or larger electrical components required by an approved pump having greater horsepower than scheduled.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

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

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.01 IN-LINE CENTRIFUGAL PUMPS

A. Close-coupled, In-line Booster Pumps, CDP-2 & 3
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ITT Corporation.
   b. PACO Pumps; Grundfos Pumps Corporation, USA.
   c. TACO Comfort Solutions, Inc.
2. Description: Factory-assembled and tested, centrifugal, close-coupled, in-line pump; designed for installation with pump and motor shafts mounted horizontally.
3. Pump Construction
   a. Casing: All bronze, rated for 125 psig working pressure.
   b. Trim: Bronze fitted.
   c. Impeller: Bronze or fiberglass composite, enclosed type.
   d. Shaft: Stainless steel or carbon steel with bronze or stainless-steel sleeves through seal chamber.
   e. Seals: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring with Buna-N bellows and gasket. Include water slinger.
   f. Bearings: Permanently lubricated ball bearings or oil lubricated bronze sleeve.
   g. Piping Connections: Flanged.
   h. Motors: Provided hereunder, see Section 23 05 13 “Common Motor Requirements for HVAC Equipment.”
   i. Motor Starters: Provided hereunder as scheduled, refer to SECTION 23 05 14 – “Motor Control Devices for HVAC Equipment.”
   j. Capacity: As scheduled on Drawings.

B. Flexible Coupling, Horizontal Mount, In-line Circulator Pumps, CDP-1
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. ITT Corporation.
   b. PACO Pumps; Grundfos Pumps Corporation, USA.
   c. TACO Comfort Solutions, Inc.
2. Description: Factory-assembled and tested, centrifugal, close-coupled, inline pump; designed for installation with pump and motor shafts mounted horizontally.
3. Pump Construction:
   a. Casing: Vertical, split case design. Cast-iron bronze fitted construction, rated for 175 psig working pressure at 225^{o}F, suction and discharge gauge ports at nozzles and vent and drain ports. Constructed to permit complete servicing without disconnecting piping or electrical connections.
   b. Impeller: Cast bronze, keyed to shaft, hydraulically and dynamically balanced.
   c. Seal: Mechanical. Internally flushed assembly. EPT Carbon face rotating against stationary silicon-carbide face.
   d. Shaft: Solid steel shaft supported by two permanently sealed ball bearings. Non-ferrous shaft sleeve to cover wetted area under sleeve.
   e. Piping Connections: Flanged.
   f. Coupling: Flexible. Replaceable.
4. Motors: Provided hereunder, see Section 23 05 13 “Common Motor Requirements for HVAC Equipment.” Motors through 1 HP resilient mount. Motors 1-1/2 HP and larger rigid mount.
5. Motor Starters: Provided hereunder as scheduled, refer to SECTION 23 05 14 – “Common Motor Control Devices for HVAC.”
6. Capacity: As scheduled on Drawings

C. Close-coupled In-line Pumps, CWP-1 & 2
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. ITT Corporation.

b. PACO Pumps; Grundfos Pumps Corporation, USA.
c. TACO Comfort Solutions, Inc.

2. Description: Factory-assembled and tested, close-coupled, inline pump designed for installation with pump and motor shafts mounted horizontally or vertically. Cast-iron stainless steel fitted construction. Rated for 175 psig working pressure at 250°F. Back pull out access allowing pump internals to be serviced without disturbing piping connections.
3. Pump Construction:
   a. Volute: Class 30 cast iron rated for 175 psig with integral cast iron flanges. Suction and discharge gauge ports at nozzles and vent and drain ports. Constructed to permit complete servicing without disconnecting piping or electrical connections. Designed with base ring matching an ANSI 125# flange for pump support.
   b. Impeller: Stainless steel impeller. Hydraulically and dynamically balanced to ANSI/HI 9.6.4.5-2000. Allowable residual imbalance to conform to ANSI grade 6.3. Keyed to the shaft and secured by stainless steel locking cap screw or nut.
   c. Seal: Internally flushed mechanical seal assembly installed in a seal chamber. Stainless steel housing, BUNA bellows and seat gasket, stainless steel spring. Carbon ceramic design with carbon face rotating against stationary ceramic face.
   d. Shaft: Solid alloy steel shaft integral to motor. Non-ferrous shaft sleeve shall completely cover the wetted area under the seal.
   e. Piping Connections: Flanged.
   f. Bearings: Heavy duty greased ball bearings.
4. Motors: Provided hereunder, see Section 23 05 13 – “Common Motor Requirements for HVAC Equipment. Provided with heavy duty grease lubricated ball bearings to offset the additional loads associated with a close coupled design.
5. Motor Starters: Provided hereunder as scheduled, refer to Section 23 05 14 – Common Motor Control Devices for HVAC.
6. Capacity: As scheduled on Drawings

2.02 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 stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.
7. Maximum Pressure Drop: 2.0 psi at design flow rate.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PUMP INSTALLATION

A. Install pumps to allow access for periodic maintenance including removing motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. In-line Pump:
1. Install in-line pumps with continuous-thread hanger rods and of size required to support weight of in-line pumps.
2. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

3.03 ALIGNMENT

A. Align pumps as recommended by pump and coupling manufacturer recommendations and Hydronics Institute standards.

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. Record field adjustments and include in the O & M manual.

3.04 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping. Install reducers or increasers as required at pump connections.

C. Provide pump trim as detailed on Drawings.

D. Provide pressure gauge. Connect gauge to pump suction and discharge casing gauge taps. Provide ball valve at each connection.

3.05 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 23 22 13

STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes pipe and fittings for low pressure and medium-pressure steam and condensate piping:
   1. Pipe and fittings.

1.02 DEFINITIONS

A. MP Systems: Medium-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
   1. MP Steam Piping: 100 psig.
   2. LP Steam Piping: 15 psig.
   3. Condensate Piping: 100 psig at 250°F.
   4. Makeup-Water Piping: 80 psig at 150°F.
   5. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

1.04 ACTION SUBMITTALS

A. Provide materials list for piping and fitting type.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

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

B. Pipe Welding: Qualify processes and operators according to the following:
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings and Unions: ASME B16.22.

2.02 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.03 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-inchmaximum thickness unless thickness or specific material is 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, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.01 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:
1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:
1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.02 MP STEAM PIPING APPLICATIONS

A. MP Steam Piping, NPS 2and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. MP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:
1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:
1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.03 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

3.04 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements unless approved by Engineer and Owner.

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 free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS ¾ full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS ¾ nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

S. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

T. Install sleeves for piping penetrations of walls, ceilings, and floors.

3.05 HANGERS AND SUPPORTS

A. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers and supports.

B. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.06 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 ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.08 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate 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. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. 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.

C. Prepare written report of testing.

END OF SECTION

SECTION 23 22 16

STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following piping specialties for steam and condensate piping:
1. Strainers.
2. Steam traps.
3. Thermostatic air vents and vacuum breakers.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of the following:
1. Steam trap.
2. Air vent and vacuum breaker.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, steam safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to the following:
1. ASME Compliance: Steam safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
1. LP Steam Piping: 50 psig.
2. Condensate Piping: 100 psig at 250°F.
3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

2.02 STRAINERS

A. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel.
   a. 2-inch and below: 20-mesh strainer.
   b. 2-/12-inch to 6”: 0.045 perforated basket.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

2.03 STEAM TRAPS

A. Float and Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco, Inc.
2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45°F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

2.04 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless-steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless-steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350°F.

B. Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: EPR.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350°F.

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Steam Traps:
1. Steam heating coils: Float and thermostatic. Flow rate and pressure drop as noted or scheduled on Drawings.

3.02 PIPING INSTALLATION

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

D. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Strainers:
1. Install strainers on supply side of control valves, traps, and elsewhere as indicated. Strainer size to match pipe size.
2. Blow-off outlet connection: Provide NPS 3/4 nipple and full port ball valve in blowdown connection of strainers
3. For steam piping, install strainers with “Y” horizontal to allow condensate to drain.

3.03 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.04 TERMINAL EQUIPMENT CONNECTIONS

A. Install traps and control valves in accessible locations close to connected equipment.

B. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION

SECTION 23 25 13

WATER TREATMENT FOR HYDRONIC SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Bypass feeders

B. Cleaning and treatment for closed loop hydronic systems

C. Cooling tower cleaning and passivation

D. Chemical treatment accessories

E. Antifreeze Systems

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Bypass feeders		X						
Cleaning and Treatment for Closed Loop Hydronic Systems	X							X
Cooling Tower Cleaning and Passivation	X							X
Chemical Treatment for Open Loop Condenser Water Systems	X	X						X
Chemical Treatment Accessories		X						
Anti-Freeze Systems	X			X				X

B. Special Requirements:
1. Manufacturer’s recommended cleaning and treatment procedures.

1.03 QUALITY ASSURANCE

A. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, and pre-treatment.

B. Approved Provider: US Water Services, ChemAqua, or approved.

PART 2 - PRODUCTS

2.01 BYPASS FEEDERS

A. Bypass Feeders:

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: Griswold Water Systems, J L Wingert, or approved.
2. Bypass Filter Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet configured to accept strainer basket, bag filters, or cartridge filters. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
    a. Capacity: 2 gal..
    b. Minimum Working Pressure: 175 psig at 250°F.
    c. Accessories:
        i. 25-micron bag filter with stainless steel basket.

2.02 CLEANING AND TREATMENT FOR CLOSED LOOP HYDRONIC SYSTEMS

A. Alkaline phosphate, non-phosphate detergent, or other approved proprietary compound suitable to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals.

B. Inhibitor: Provide sodium silicate, sodium nitrite/borate, or other approved proprietary compound suitable for make-up quality and make-up rate and which will not cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

C. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.0.

D. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling.

E. Chemicals
1. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

2.03 COOLING TOWER CLEANING AND PASSIVATION

A. Water pH and Calcium Concentration Control: Treatment chemical formulation shall be compatible with cooling tower manufacturer’s recommendations. Passivation water treatment formulation shall include adequate buffer to maintain pH range of 7.0 to 8.0. Maintain Calcium Carbonate (CaCO3) concentration above 50 ppm and below 300 ppm.

B. Cleaning compounds: Pre-passivation cleaning materials and solutions may include surfactants, but shall not include compounds with pH less than 6.5 or greater than 8.0.

2.04 ANTIFREEZE SYSTEMS

A. Antifreeze Solution:
1. Acceptable Manufacturer: Dow "DOWFROST" or approved
2. Materials:
    a. Industrially inhibited propylene glycol (phosphate-based). Specifically excluded are automotive antifreezes or any formulations containing silicates.
    b. Fluid shall be dyed to facilitate leak detection.

c. Fluid shall be easily analyzed for glycol concentration and inhibitor level, and easily reinhibited using replacement inhibitor readily available from the fluid manufacturer.
d. Provide a convenient analytical test aid for use by system operator.
e. Fluid shall pass STM D1384 (less than 0.5 mils penetration per year for all system metals.)

B. Antifreeze Solution Make-up Unit, GF-1
1. Acceptable Manufacturer: Bell & Gossett, Wessels Co., Advantage Controls, or approved. Similar to Advantage Controls GF-1A3A series.
2. Packaged assembly consisting of:
a. Reservoir Tank: Industrial grade polyethylene reservoir, removable to cover, visible solution level scale, 2-inch fill/vent opening in top cover. Minimum 55-gallon capacity.
b. Pump: Close coupled centrifugal. 6.1 gpm at 60 psi total head, 3/4 hp motor, 120 volt.
c. Piping & Trim: ¾-inch schedule 80 PVC piping. Provide piping accessories as follows: ball valve, wye strainer, union, pump, union, check valve, balancing valve, isolation valve, pressure gauge.
d. Painted steel stand.
e. Electrical Connections: Single point connections, 120-volt, single phase, 60 hz.
f. Automatic Control and Monitoring:
1) Motor contactor
2) Pump controller: adjustable pressure pump start and stop pressure setpoints and tank level alarm.
3) Low level alarm: Stop pump whenever low water level occurs, activate red indicator light on panel door, and activate low water alarm contact for remote BAS alarm monitoring.
4) Power indicator light: green indictor light in panel door.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

C. Where work includes the expansion of an existing hydronic system the Contractor is responsible for cleaning and treatment of new portions only, unless the working fluid in the existing system must be drained to perform work. Then the entire systems must be cleaned and treated. Where fluid in an existing system is retained, the contractor shall test water chemical treatment concentrations prior to beginning work and provide a preliminary test report to the Owner’s Authorized Representative describing any deficient conditions. Any modification of an existing system prior to submitting preliminary test report constitutes acceptance of existing conditions.

D. Provide branch connections, isolation valves, bypass piping and all other temporary facilities necessary to perform work specified herein, including circulation pumps to facilitate cleaning.

E. Antifreeze Solution
1. Clean piping system as specified for closed loop hydronic systems. Prior to the installation of industrially inhibited propylene glycol fluid.
2. Provide water test prior to filling the system. Test to verify that water has less than 50 ppm of chloride, sulfate, and hard water ions (Ca++, Mg++) before antifreeze is

added. If water does not meet specified criteria, provide chemical treatment as required to bring into compliance prior to adding antifreeze. Submit test results to Engineer and Owner for approval.

F. Antifreeze Solution Make-up Unit:
1. Anchor assembly securely to floor.
2. Adjust pressure setpoint to maintain minimum system operating pressure.
3. Adjust pump flow rate to prevent pump cavitation.

3.02 CLOSED LOOP HYDRONIC SYSTEMS

A. Preparations
1. Open all valves and make adjustments as necessary to ensure water flow through all piping.
2. Flush system to force large material to strainers
3. Clean all strainers prior to cleaning

B. Cleaning
1. Add cleaning compound to system and circulate minimum of 24 hours in accordance with manufacturer's recommendations.

C. Flushing
1. Drain system neutralizing cleaning solution as required by local governing authority.
2. Continue flushing until cleaning agent concentration is less than 10 ppm, pH is between 7 and 8, water quality of system water is equivalent to makeup water quality, and system water drawn from any branch line is clear when observed in a white cup.
3. Clean strainers.

D. Treatment
1. Add corrosion inhibitor and recirculate system for a minimum of 8 hours. If inhibitor concentration is below manufacturer's recommendations, add more inhibitor and repeat process until desired level is obtained.

E. Bypass Feeders: Install in closed hydronic systems where shown on drawings, and equipped with the following:
1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
3. Install a full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
4. Install a swing check and site glass on the inlet after the isolation valve.

3.03 COOLING TOWER CLEANING AND PASSIVATION

A. Cleaning: Fill cooling tower sump, circulate tower water for a minimum of 10 minutes, then completely drain the tower sump. Repeat a minimum of two times, or as recommended by the cooling tower manufacturer. Remove all debris and sediment from the cooling tower sump.

B. Passivation Timing and Duration: Commence passivation immediately after cleaning is complete. Passivation will occur with the chilled water system and towers on line. Passivation of the cooling tower(s) shall be performed for a minimum of eight (8) weeks.

C. Passivation:
1. Circulate tower water during the entire duration of the passivation process.
2. Maintain pH, conductivity, water hardness, and chemical concentrations in the ranges listed below, or as recommended by the cooling tower manufacturer. The listed or

recommended values shall be maintained during the entire duration of the passivation process.

a.	pH:	7.0 - 8.0
b.	Conductivity:	<2,400
c.	Calcium Hardness:	>50 ppm, <300 ppm
d.	Chlorides:	<250 ppm
e.	Sulfates:	<250 ppm
f.	Alkalinity	<300 ppm
g.	Chlorine (Biocide)	<0.5 ppm

3.04 TRAINING

A. Provide operator training. Schedule training with Owner. Training to include the following:
1. Operation of all water treatment equipment provided
2. Water treatment chemical handling and safety
3. Testing of system operational parameters and required adjustments when “out of specification” conditions are identified.

3.05 REPORT

A. Submit treatment report to Engineer and Owner describing cleaning and treatment processes, chemicals used, and test results. Include copy of treatment report in O&M manual.

END OF SECTION

SECTION 23 31 13

METAL DUCTWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes metal ductwork, and related fittings and sealants.

1.02 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.03 ACTION SUBMITTALS

A. See Section 23 05 00 for general submittal requirements.

B. Materials List:
1. Shop fabricated ductwork:

C. Catalog Data:
1. Pre-manufactured Ductwork and Fittings.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. Comply with applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Sealing Requirements:
1. Concealed: Seal longitudinal seams and transverse joints with liquid duct sealer or tape-and-adhesive. Flanged, gasketed joints that meet seal requirements do not require separate duct sealant application.
2. Exposed: Seal non-flanged transverse joints with liquid duct sealer, specified herein, applied to male end fittings only, so that sealer is not visible when joint is assembled.

2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. General: Round ductwork may be either shop or factory fabricated. Flat-oval ductwork shall be factory fabricated.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering factory fabricated products that may be incorporated into the Work include, but are not limited to the following:
1. McGill AirFlow LLC.
2. MKT Metal Manufacturing.
3. Sheet Metal Connectors, Inc.
4. Spiral Manufacturing Co., Inc.

D. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

E. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

G. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing

requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

H. Sealing Requirements:
1. Concealed: Flanged, gasketed joints that meet seal requirements do not require separate duct sealant application.
2. Exposed: Seal non-flanged transverse joints with liquid duct sealer, specified herein, applied to male end fittings only, so that sealer is not visible when joint is assembled.

2.03 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

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

2.04 SEALANT AND GASKETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries
2. McGill AirSeal LLC.
3. Carlisle HVAC Products

B. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel and stainless-steel sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.05 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved by Engineer and Owner.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

A. Provide Seal Class in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"

B. Clean duct surfaces prior to applying sealant.

C. Prior to application, verify that ducts are dry and within specified temperature limits.

D. Open ends of completed and overnight work-in-progress shall be sealed.

3.04 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

6. Confirm design of existing concrete slabs prior to installing fasteners. Where existing slabs contain embedded components such as tension cables. Locate embedded components and install fasteners to so that embedded components remain undamaged.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. See Section 23 05 48 “Vibration and Seismic Controls for HVAC.”

3.06 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.07 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.08 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
1. Exhaust ductwork from room to filter housing inlet: stainless steel.

B. Seal Class
1. Class A

C. Leakage Class
1. Leakage Class 4

D. All ductwork single-wall, unless otherwise indicated.

E. Supply Ducts:
1. Ducts Connected to Constant-Volume Air-Handling Units:
   a. Single wall
   b. Pressure Class: Positive3-inch w.g

F. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air between room served and filter housing:

a. Single-wall
b. Type 316, stainless-steel sheet.
1) Exposed to View: No. 4 finish.
2) Concealed: No. 2B finish.
c. Pressure Class: Positive or negative 6-inch wg.
d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
e. SMACNA Leakage Class: 3.

2. Ducts Connected to exhaust filter housings to point of discharge:
a. Single-wall
b. Galvanized steel.
c. Pressure Class: Positive or negative 4-inch wg.

G. Intermediate Reinforcement: Match duct material.

H. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Velocity 800 fpm or Lower:
1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.
b. Velocity 800 to 1500 fpm:
1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

I. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch:
1) Velocity less 1000 fpm: Conical tap or 45-degree entry.
2) Velocity 1000 fpm or Higher: 45-degree entry.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
a. Velocity less 1000 fpm: Conical tap or 45-degree lateral.
b. Velocity 1000 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Accessories for duct systems.

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Manual Volume Dampers		X						
Automatic Dampers			X	X				
Turning Vanes		X						
Duct Mounted Access Doors		X						
Duct Connectors		X						

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

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

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

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

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

2.03 MANUAL VOLUME DAMPERS

A. Acceptable Manufacturers
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. Greenheck
   b. Nailor Industries Inc.
   c. Pottorff.
   d. Ruskin Company.
   e. Trox USA Inc.
   f. Young Regulator Company.

B. Round/Oval Single Blade Manual Volume Dampers:
1. Operating Conditions:
   a. Maximum temperature: 180°F
   b. Maximum differential pressure: 1-inch water column.
   c. Maximum air velocity: 2,000 fpm.
   d. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames:
   a. One piece 20-gauge construction. Material to match connected ductwork.
4. Blades:
   a. Single blade.
   b. 20-gauge construction. Material to match connected ductwork.
   c. Stiffen damper blades for stability.
5. Blade Axles: Minimum 3/8-inch dia. plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.
6. Bearings:
   a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
   b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Actuator:
   a. Manual quadrant, except where remote damper operator is required.
   b. Elevated platform for insulated duct mounting.

C. Round Multiple Blade Manual Volume Dampers:
1. Operating Conditions:
   a. Maximum temperature: 180°F
   b. Maximum differential pressure: 4-inch water column.
   c. Maximum air velocity: 2,500 fpm.
   d. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames:
   a. One piece 10-gauge construction. Material to match connected ductwork.
4. Blades:
   a. Multiple blade.

b. 16-gauge construction. Material to match connected ductwork.
c. Stiffen damper blades for stability.

5. Blade Axles: Minimum 1/2-inch dia. plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.
6. Bearings:
   a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
   b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Actuator:
   a. Manual quadrant, except where remote damper operator is required.
   b. Elevated platform for insulated duct mounting.

D. Single Blade Rectangular Manual Volume Dampers:
1. Operating Conditions:
   a. Maximum temperature: 180°F
   b. Maximum differential pressure: 1-inch water column.
   c. Maximum air velocity: 2,000 fpm.
   d. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames: Hat-shaped, welded or gusset reinforced corners. 18-gauge construction. Material to match connected ductwork.
4. Blades:
   a. Single blade.
   b. 20-gauge construction. Material to match connected ductwork.
   c. Stiffen damper blades for stability.
5. Blade Axles: Minimum ½ inch dia. plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.
6. Linkages: Concealed in jamb outside or air stream.
7. Bearings:
   a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
   b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Actuator:
   a. Manual quadrant, except where remote damper operator is required.
   b. Elevated platform for insulated duct mounting.

E. Multiple Blade Rectangular Manual Volume Dampers:
1. Operating Conditions:
   a. Maximum temperature: 180°F
   b. Maximum differential pressure: 4-inch water column.
   c. Maximum air velocity: 2,000 fpm.
   d. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames:
   a. Hat-shaped, welded or reinforced corners. Material to match connected ductwork.
      1) Galvanized steel or stainless steel: 16-gauge.
      2) Aluminum: 12-gauge.
   b. Mitered corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
   a. Opposed blade.
   b. Rolled Formed. Material to match connected ductwork.
      1) Galvanized steel or stainless-steel: 16-gauge.
      2) Aluminum: 12-gauge.
   c. Stiffen damper blades.
5. Blade Axles: Minimum ½ inch diameter plated-steel or stainless-steel, except stainless-steel where adjacent ductwork is aluminum or stainless-steel.

6. Bearings:
   a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
   b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Actuator:
   a. Manual quadrant, except where remote damper operator is required.
   b. Elevated platform for insulated duct mounting.
8. Transitions: Provide factory transitions for connection to round and oval ductwork as required.

2.04 AUTOMATIC DAMPERS

A. High Performance Control Dampers
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Tamco
2. Basis of Design: Tamco Series 1000 Low Leakage Air-Foil Control Damper.
3. Operating Conditions: -40°F to 210°F
4. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
   a. Leakage Class: 1A at 1-inch w.g. static pressure differential.
5. Frames:
   a. U shaped 6063-T5 extruded channel, 12-gauge thickness.
   b. 4-inch width with mounting flange on both sides.
6. Blades:
   a. Multiple blade with maximum blade width of 6 inches.
   b. Opposed blade design, except where otherwise indicated.
   c. 6063-T5 extruded aluminum, 16-gauge thick dual skin air-foil with overlapping seal surface.
   d. Blade Seal: extruded EPDM mechanically fastened in slot of overlapping blade extension.
   e. Frame Seal: Extruded silicone mechanically fastened in integral slot within frame extrusion.
7. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of aluminum or zinc-plated steel.
8. Bearings:
   a. Dual bearing system composed of a Celcon inner bearing, fixed around aluminum blade pivot pin, rotating within a polycarbonate outer bearing inserted in the frame.

2.05 TURNING VANES

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. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. SEMCO LLC.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

C. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

D. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

E. Vane Construction: Single wall for ducts up to 18 inches wide and double wall for larger dimensions.

2.06 DUCT-MOUNTED ACCESS DOORS

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. Cesco Products; a division of MESTEK, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access doors less than 12 inches square: No hinges and two sash locks.
   b. Access doors up to 24 inches square: Continuous and two sash locks.
   c. Access doors larger than 24 by 24 inches: Continuous and two compression latches with outside and inside handles.

2.07 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Hardcast, Inc.
5. JP Lamborn Co.
6. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd.
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500°F.

2.08 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

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

C. Provide low leakage control dampers as close as possible to the inlet of building exhaust fans as required by Oregon Energy Efficiency Specialty Code.

D. Install products in locations that are accessible and that will permit adjustment 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.

E. Manual Volume Dampers:
1. Install in ductwork where shown on Drawings and as required to properly balance airflow rates to values shown on Drawings. Provide damper for each air inlet and outlet.
2. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
3. Dampers must be accessible to allow inspection, adjustment, and replacement of components.
   a. Where manual actuators are not accessible for adjustment provide remote manual cable actuator. An actuator is not accessible if it is located more than 24 inches horizontally from an access point or more than 48 inches above an access point. Coordinate location of actuator drive assembly with Engineer and Owner’s Construction Manager.
4. Do not compress or stretch the damper frame into the duct or opening. Damper shall move freely throughout full range of travel.
5. Dampers shall be rigid and secure not producing any audible noise due to vibration of components.
6. Set dampers to fully open position before testing, adjusting, and balancing.

F. Automatic Dampers
1. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
2. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact on performance.
3. Unless specifically designed for vertical blade application, dampers mounted with blades horizontal.
4. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.
5. Seal between damper frame and ductwork and between multiple damper sections to prevent leakage around perimeter of damper.
6. Provide a minimum of one damper actuator per damper section.
7. Provide ceiling, floor, roof, and 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.
8. Seal penetrations made in fire-rated and acoustically rated assemblies.

9. Service Access:
    a. Dampers and actuators shall be accessible for visual inspection and service.
    b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator.

G. Turning Vanes
1. Install in mitered ductwork elbows and as shown on Drawings.
2. Install with leading and trailing edges parallel to entering and leaving airflow.

H. Duct-mounted Access Doors:
1. Install on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
    a. On both sides of duct coils.
    b. Upstream from duct filters.
    c. At outdoor-air intakes and mixed-air plenums.
    d. At drain pans and seals.
    e. Control devices requiring inspection.
    f. Elsewhere as indicated.
2. Install access doors with swing against duct static pressure.
3. Access Door Sizes:
    a. One-Hand or Inspection Access: 8 by 5 inches.
    b. Two-Hand Access: 12 by 6 inches.
    c. Head and Hand Access: 18 by 10 inches.
4. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

I. Flexible Connectors
1. Install flexible connectors to connect ducts to equipment.
2. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
    a. Secure outer liner with nylon draw strap.

J. Test Holes
1. Install test holes at fan inlets and outlets, coil inlets and outlets, and elsewhere as indicated.

3.02 APPLICATION

A. Manual Volume Dampers:
1. Material: Volume damper construction frame and blade material shall match material of connected ductwork.
2. Type:
    a. Round/Oval Single Blade Manual Volume Dampers: All round ductwork 20-inch diameter and below.
    b. Round Multiple Blade Manual Volume Dampers: All round ductwork greater than 20-inch diameter in exposed or concealed locations.
    c. Rectangular Single Blade Manual Volume Dampers: Rectangular ductwork where largest cross-sectional dimension is 18-inches and below.
    d. Rectangular Multiple Blade Manual Volume Dampers:
        1) Round or oval ductwork greater than 20-inch diameter located in concealed locations. Provide rectangular to round transition for connecting to round ductwork.
        2) Rectangular or oval ductwork where largest cross-sectional dimension greater than 18-inches. Provide rectangular to oval transition for connecting to oval ductwork.

B. Flexible Connectors
1. Indoor system: All indoor applications, except where otherwise required.
2. Outdoor system: All outdoor applications, except where otherwise required.

3. High-Temperature System: Indoor or outdoor applications where the maximum air temperature may exceed 180°F.
4. High-Corrosive-Environment: Indoor or outdoor applications where connector may be in contact with corrosive gases including exhaust air from chemical fume hoods, storage rooms, or storage equipment.

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.
4. Operate remote damper operators to verify full range of movement of operator and damper prior to covering work or limiting access for inspection.

B. Control-Damper Checkout:
1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is unobstructed.
9. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Exhaust Fans (EF)

1.02 QUALITY ASSURANCE

A. Fan performance ratings for air flow, pressure, power, air density, speed of rotation, and efficiency shall be factory tested and ratings established in accordance with AMCA Standard 210. Air foil blade fans shall bear AMCA rating seal.

B. Sound power level ratings shall be established in accordance with AMCA 300.

C. Equipment performance shall be calculated using actual project conditions.

1.03 DESIGN REQUIREMENTS

A. Equipment performance calculated using project site elevation.

1.04 REFERENCES

A. Air Movement and Control Association (AMCA):
1. 210 Test Code for Air Moving Devices
2. Test Code For Sound Rating

PART 2 – PRODUCTS

2.01 PLENUM SUPPLY FANS, SF-1 & SF-2

A. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
1. Fans: Aluminum airfoil, class II, direct-drive arrangement. Individually housed. AMCA certified.
2. Fan Housing: Aluminum or stainless steel with perforated inner liner, and melamine insulation. Solid or perforated outer panels as required by application.
3. Mounting: Fan and motor mounted with the housing on an adjustable slide rail base. Capable of either vertical or horizontal applications.
4. Balancing: At manufacturer’s option, fans may be balanced to a standard which eliminates the need for internal spring isolation.
   a. For fans without internal spring isolation, fan and motor assembly dynamically balanced to meet AMCA standard 204-96 for fan application class BV-5 to produce a maximum rotational imbalance of .022 inches/second peak at the submitted design operating speed.
   b. For fan with internal spring isolation, fan impellers shall be statically and dynamically balanced to meet AMCA standard 204-96 for fan application class BV-3.
5. Fan and motor assemblies designed for application in multiple fan arrays.

B. Fan Backdraft Dampers
1. Each fan provided with an integral back flow prevention device that prohibits recirculation of air in the event one or more fans become disabled. The associated system effect shall be included in the calculation of total fan static pressure loss. Motorized dampers or other motorized devices are not acceptable.
2. Manufacturer's Warranty:

a. Manufacturer agrees to repair or replace dampers that fail in materials or workmanship within specified warranty period.
b. Warranty Period: Ten-years from date of substantial completion.

C. Fan Airflow Monitoring
1. Noninvasive, zero pressure drop, pressure sensing taps installed in the fan inlet cone for airflow monitoring. No transmitter.

D. Multiple Fan Arrays
1. The fan array shall consist of multiple housed fans spaced in the airway tunnel cross section to provide a uniform velocity profile across the air tunnel and components.
2. Each fan and motor assembly shall be removable through a 24-inch wide access door on the discharge side of the fan array without removing fan wheel from the motor.
3. All fans in multiple fan arrays shall be AMCA certified for performance per AMCA arrangement “A” testing configuration. Submitted performance data shall include system effects associated with the fan mounting arrangement, fan enclosures, back draft dampers, and all other fan components.

E. Internal Vibration Isolation and Seismic Control:
1. For fans balanced to meet AMCA standard 204-96 for fan application class BV-5, Fan Array shall be isolated with neoprene mounting washers.
2. For fans balanced to meet AMCA standard 204-96 for fan application class BV-3, Fan Array shall be factory mounted with manufacturer's standard seismically restrained vibration isolation mounting devices having a minimum static deflection of 2 inches.
3. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 23 0548 "Vibration and Seismic Controls for HVAC" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.

F. Sound power levels for units and components shall not exceed values listed below:

SOUND POWER LEVELS (db)								
Frequency	63	125	250	500	1000	2000	4000	8000
SF-1 & 2 Combined								
Inlet	89	93	87	79	78	74	66	62
Outlet	88	90	87	85	84	79	79	67

G. Variable Frequency Drive Controllers: Provided hereunder. See Section 23 05 14 - “Common Motor Control Devices for HVAC Equipment.”

1. Provide separate Variable Frequency Drives to control speed for each of the fan array motors. Size to start and hold all connected motors. See Section 23 05 14 “Common Motor Control Devices for HVAC Equipment.”

2. Mount Variable Frequency Drive in a dedicated enclosure for connection to a single power source. Provide enclosure with a main disconnecting means.

3. Provide motor circuit protector. Motor circuit protector housed in the Variable Frequency Drive enclosure.

H. Motors: Provided hereunder. See Section 23 05 13 “Common Motor Requirements for HVAC Equipment.”

2.02 UTILITY SET EXHAUST FANS, EF-1 through EF-4)

A. Acceptable Manufacturers: Carnes, Greenheck, ILG, Loren Cook Co., Penn Barry. Similar to Greenheck USF series.

B. Description: Factory assembled utility set type fans, consisting of fans, motor and drives, and accessories.

C. Housing: Heavy gauge stainless steel, continuously welded airtight. Rigidly braced with welded structural steel frame. Bolted access door. Bearing supports shall be rigid and properly braced to provide firm foundations for shaft and bearing. 3/4" NPT drain connection at low point. Formed steel pedestal base, factory finished.

D. Fans: Type and performance as scheduled. Aluminum construction, with Backward inclined, non-overloading. Spun stainless steel inlet cone. Statically and dynamically balanced wheel and shaft. Solid, ground, and polished stainless steel shafts, keyed to wheel.

E. Bearings: Air handler quality, self-aligning, grease lubricated, pillow block, selected for a minimum L50-200,000 hours at maximum cataloged operating conditions in accordance with ABMA-9. Grease fittings extended to accessible location.

F. Drive and Belts: Provided hereunder. See Section 23 05 31 – V-BELTS AND SHEAVES.

G. Motor: Provided hereunder. See Section 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.

H. Motor Starters: Provided hereunder as scheduled, refer to SECTION 23 05 14 – COMMON MOTOR CONTROL DEVICES FOR HVAC.

I. Sound power levels for units and components shall not exceed values listed below:

SOUND POWER LEVELS (db)								
Frequency	63	125	250	500	1000	2000	4000	8000
EF-1 through EF-4								
Exhaust inlet	89	81	79	79	78	73	72	69
Exhaust outlet	98	94	87	86	76	73	69	66

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:
1. Install supply fans on existing concrete pads on floor within air handler.

3.02 INSPECTION

A. Install fan level and plumb as recommended by manufacturer.

B. Install fans with clearances for service and maintenance.

C. Make final connections with flexible connectors.

D. Ground equipment in accordance with manufacturer's recommendations. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values

E. Install belt guards.

3.03 FIELD QUALITY CONTROL

A. Equipment Start-up Checks
1. Verify shipping, blocking, and bracing has been removed.

2. Verify that unit is secure on mountings and supporting devices, and that connection to ducts and electrical components are complete.
3. Verify that proper thermal overload protection is installed in motors, starters, and disconnect switches. Adjust overload settings for fan motor rated load amperage.
4. Verify that cleaning and adjusting is complete.
5. Verify motor rotation direction.
6. Verify that fan wheel rotates freely and the bearing operation is smooth.
7. Verify lubrication of bearing and other rotating parts.
8. Verify that manual and automatic volume control dampers and fire and smoke dampers in ductwork work system are fully open.

B. Start-up Procedures:
1. Energize fan motor.
2. Measure and record motor voltage and amperage.

3.04 ADJUSTING

A. Align belts and sheaves.

B. Adjust belt tension in accordance with manufacturer’s recommendations.

C. Lubricate bearings.

END OF SECTION

SECTION 23 37 13

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Grilles

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.

PART 2 - PRODUCTS

2.01 COMMON REQUIREMENTS

A. Source Quality Control
1. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, unless specifically stated otherwise:
1. Anemostat Products; a Mestek company.
2. Krueger.
3. Nailor Industries Inc.
4. Price Industries.
5. Titus.

2.02 SUPPLY GRILLES

A. Adjustable Blade Register SG-1
1. Basis of Design: Titus 300 RL/RS
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Blade Arrangement: Individually adjustable horizontal and vertical blades, front blades parallel to long dimension. Spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. Mounting:
   a. Surface: Countersunk screw.
   b. Suspended Ceiling: Flush, border type and module size compatible with ceiling system.
   c. Exposed: Countersunk screw.

2.03 RETURN GRILLES

A. Fixed Blade Grille RG/EG-1
1. Basis of Design: Titus 350 RL/RS
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Blade Arrangement: 35-degree blade deflection. Spaced 3/4 inch apart. Blades parallel to long dimension if installed in ceiling or horizontal position. Blades parallel to floor if installed in wall or vertical position.

5. Frame: 1-1/4 inches wide.
6. Mounting:
    a. Surface: Countersunk screw.
    b. Suspended Ceiling: Flush, border type and module size compatible with ceiling system.
    c. Exposed: Countersunk screw.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where existing architectural features or other items conflict with installation, notify Engineer and Owner for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Mounted devices tight to finished surface

3.03 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 41 00

PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Pleated panel filters.
2. HEPA Rigid-Cell Box Filters
3. Front Access Filter Racks
4. Safe Change Filter housings.
5. Filter gages.

1.02 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All filters		x						x
Frames and housings			x			x		x
Filter gages		x						x

B. Shop Drawings: For custom air filters. Include plans, elevations, sections, details, and attachments to other work.
1. Show ASU-1 replacement filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.04 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Provide two complete set(s) of filters for each filter bank. Filters shall be clean at date of Substantial Completion. Filters furnished herein shall be in addition to those provided to replace filters used during construction.

1.05 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.01 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. AAF International.
b. Camfil Farr.
c. Flanders Corporation.

B. Filter Unit Class: UL 900, Class 2.

C. Media: Cotton and synthetic fibers coated with nonflammable adhesive.
1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Media shall be coated with an antimicrobial agent.
4. Separators shall be bonded to the media to maintain pleat configuration.
5. Welded wire grid shall be on downstream side to maintain pleat.
6. Media shall be bonded to frame to prevent air bypass.
7. Support members on upstream and downstream sides to maintain pleat spacing.

D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Capacities and Characteristics:
1. Designation: F-1
a. Face Dimensions:
1) Air Handler: 20x20
2) Exhaust housings: 24x24.
b. Depth: 2 inches.
c. Initial Pressure Drop: 0.33-inches w.g. at 500 fpm.
d. Final Resistance: 1 inch-w.g. at 500 fpm.
e. Maximum Rated Pressure Drop: 2-inches w.g.
f. MERV Rating: 8 when tested according to ASHRAE 52.2.

2.02 HEPA RIGID-CELL BOX FILTERS

A. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow and holding frames.
1. Manufacturers: Subject to compliance with requirements, provide products by the following: AAF International, Camfil Farr, Flanders Corporation. Similar to Camfil Farr PH Absolute.

B. Standards:

1. Comply with IEST-RP-CC001.6.
2. Comply with UL 586.
3. Comply with IEST-RP-CC034.4.

C. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.
1. Internal Separators: Corrugated aluminum.
2. Media to Filter Frame Seal Material: Polyurethane.
3. Faceguard Material: None.

D. Filter-Media Frames:
1. Material: Fire-retardant plywood or Fire-retardant particleboard.
2. Filter Frame to Mounting Frame Seal Material: Urethane foam.
3. Filter Frame to Mounting Frame Seal Location: Downstream.
4. Style: Box.

E. Capacities and Characteristics:
1. Designation: F-2
   a. Face Dimensions: 24x24.
   b. Depth: 12 inches.
   c. Initial Pressure Drop: 1.33-inches w.g. at 500 fpm.
   d. Final Resistance: 2 inch-w.g. at 500 fpm.
   e. Maximum Rated Pressure Drop: 4-inches w.g.
   f. Minimum Efficiency: 99.97% HEPA.

2.03 FRONT ACCESS FILTER HOUSINGS (AIR HANDLER)

A. Description: Galvanized-steel framing members with access for either upstream filter servicing, cut to size and pre-punched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
1. Manufacturers: Subject to compliance with requirements, provide products by the following: AAF International, Camfil Farr, Flanders Corporation, or approved. Similar to Camfil Farr Type 8.

B. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

C. Capacities and Characteristics:
1. Designation: FH-1
   a. Pressure Rating: +/- 6.0 inches w.g.
   b. Airflow Rate: 32,000 cfm
   c. Face Dimensions: 96 inches high x 168 inches wide.
   d. Configuration: 4 high x 7 wide.
   e. Filter Quantity: 28, 24 inch x 24 inch filters.
   f. Prefilter Type: F-1
   g. Prefilter Depth: 2 inch

2.04 SAFE CHANGE FILTER HOUSINGS (EXHAUST)

A. Description: Factory-assembled, safe change service housings, constructed of painted 14-gauge carbon steel welded joints with flanges to connect to duct or casing system. Provide independent tracks for prefilters and final filters. At contractor option, furnish either factory inlet and outlet connections, or fabricated parts, with construction to match factory assembled
1. Manufacturers: Subject to compliance with requirements, provide products by the following: AAF International, Camfil Farr, Flanders Corporation. Similar to Camfil Farr CamSafe 2.

B. Capacities and Characteristics:

1. Designation: FH-2
    a. Minimum Pressure Rating: +/- 6.0 inches w.g.
    b. Airflow Rate: 800 cfm
    c. Configurations: 1 high x 1 wide.
    d. Filter Quantity: 1, 24 inch x 24 inch filter.
    e. Access Door: Location and swing as shown on Drawings
    f. Prefilter Type: F-1
    g. Prefilter Depth: 2 inch
    h. Final Filter Type: F-2
    i. Final Filter Depth: 12 inch

2.05 FILTER GAGES

A. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment. Gages located outdoors shall have waterproof enclosure and sun shield.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Dwyer Instruments, Inc.

B. Size and Scale
1. Diameter:4-1/2 inches.
2. Scale Range:
    a. Filter Final Resistance of 0.5-Inch wg and Less: 0 to 0.5-inch wg.
    b. Filter Final Resistance of 0.5 to 1.0-Inch wg: 0 to 1.0-inch wg.
    c. Filter Final Resistance of 1.0 to 2.0-Inch wg: 0 to 2.0-inch wg.
    d. Filter Media Final Resistance of 2.0 to 4.0-Inch wg: 0 to 4.0-inch wg.

C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Sizing:
1. Select filter frames and housing to allow use of standard, readily available filter sizes.
2. Metric size filters not allowed.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Install filter gage for each filter bank.

E. Air Handler ASU-1 pre-filter rack replacement: Provide perimeter blank-off supports and material, attached to existing unit interior walls, and sealed air tight at seams.

F. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

G. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position.

H. Coordinate filter installations with duct and air-handling-unit installations.

I. Filters shall fit in racks without bending, distortion, or modification.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Test for leakage of unfiltered air while system is operating.

C. Air filter will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.03 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 23 64 32

WATER CHILLERS, AIR-COOLED

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Packaged air-cooled water chillers

1.02 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 – General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section			X	X	X	X	X	

1.03 QUALITY ASSURANCE

A. Performance rated in accordance with AHRI Standard 550/590, latest revision.

B. In compliance with ASHRAE Standard 90.1 efficiency standards.

C. Comply with ASHRAE 15 Safety Code, NEC, and ASME standards for unfired pressure vessels.

D. Sound power data measured in accordance with ARI 370.

E. Chiller unit installed, serviced, and started by refrigeration organization with service personnel regularly serving the location of the project site and with minimum five years' commercial experience in serving air-cooled water chillers of specified capacity.

F. Unit full-load run-tested at the Factory.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver unit in manufacturer's original packaging.

B. Store in accordance with manufacturer’s recommendations. Protect from moisture and other deteriorating elements.

1.05 PROJECT CONDITIONS

A. Outdoor ambient temperatures during normal operation from 25ºF to 125ºF.

B. Chilled water temperature at startup as high as 95ºF.

PART 2 - PRODUCTS

2.01 AIR-COOLED WATER CHILLER, SCROLL COMPRESSOR

A. Acceptable Manufacturers: Carrier, Trane, York.

B. General: Factory assembled, tested and packaged, air-cooled water chiller. Complete with evaporator, condenser, compressors, motors, motor starters, and controls. Factory-charged and complete with accessories listed.
1. Refrigerant: R410a
2. Capacity control stages, minimum: six
3. Minimum operating capacity: 12%

C. Cabinet:
1. Heavy-gauge, galvanized steel frame
2. Galvanized steel exterior panels with a baked enamel powder or pre-painted finish.
3. Cabinet capable of withstanding 500-hour salt spray test in accordance with the ASTM B-117.

D. Compressor:
1. Direct drive, hermetic or semi-hermetic scroll compressors.
2. Compressor fitted with crankcase heaters, centrifugal oil pump, oil level sight glass, and oil change valve.

E. Evaporator:
1. Heat Exchanger:
   a. Mechanically cleanable, shell-in-tube evaporator with seamless copper tubes, roller-expanded into tube sheets. Removable heads. Designed and stamped in accordance with ASME code for refrigerant side working pressure of 450 psig. Tested for a maximum water side pressure of 300 psig.
2. Shell shall be insulated with minimum 3/4-inch closed-cell foam with a maximum K factor of 0.28.
3. Drain connections, vent, bulb well for low temperature cutouts and temperature controller sensor.
4. 3/4-inch closed-cell, polyvinyl-chloride insulation (K = 0.28)
5. Mechanical joint connections
6. Refrigerant level sensing device

F. Condenser:
1. Type: Aluminum microchannel.
2. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
3. Single- or multiple-pass arrangement.
4. Condensers to be factory leak-tested at 650 psig pressure.
5. Direct-drive, vertical-discharge condenser fans statically and dynamically balanced. Totally enclosed, three phase condenser fan motors with permanently lubricated ball bearings and three phase thermal overload protection. Fans protected by coated steel wire safety guards.

G. Refrigerant Circuit:
1. Two independent refrigerant circuits.
2. Each refrigerant circuit to include replaceable core filter drier, liquid line shutoff valves, moisture indicating sight glass, expansion valve, and complete operating charge of refrigerant and oil.

H. Controls:
1. Microprocessor control system and diagnostic display panel with keypad.
2. BAS Communication Interface:
   a. BACnet: factor furnished interface between the chiller and BACnet local area network.

3. Unit controls shall include the following components:
   a. Auto/Stop control switch
   b. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
   c. Control transformer to serve all controllers, relays, and control components.
   d. Replaceable solid-state controllers
   e. Pressure sensors to measure suction and discharge pressure for each circuit.
   f. Thermistors shall be installed to measure cooler entering and leaving fluid temperatures, outdoor ambient temperature, and suction temperature.
4. Capable of performing the following functions:
   a. Automatic compressor sequencing
   b. Capacity control based on leaving chilled water temperature with temperature setpoint accuracy to 0.1°F.
   c. Condenser fan sequencing.
   d. Load limiting and anti-recycle functions
   e. Remote chilled water temperature reset using 4 to 20 mA input signal.
   f. Interlock with factory-installed thermal dispersion minimum flow switch.
   g. Limiting the chilled fluid temperature pulldown rate at start-up to an adjustable range of 0.2° F to 2° F per minute to prevent excessive demand spikes at start-up.
   h. Leaving chilled fluid temperature reset from return fluid and outside air temperature.
   i. Chilled water pump start/stop control and primary/standby sequencing to ensure equal pump run time.
   j. Low ambient protection to energize cooler and hydronic system heaters.
   k. Periodic pump start to ensure pump seals are properly maintained during off-season periods.
   l. Nighttime sound mode to reduce the sound of the machine by a user-defined schedule.
5. Diagnostics:
   a. Display module to display setpoints, time, system status including temperature, pressures, and percent loading, and any alarm or alert conditions.
   b. Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions, time and date stamp event entry.
   c. Information included for display shall be:
      1) Compressor lockout. Opportunity
      2) Loss of charge
      3) Low fluid flow
      4) Cooler freeze protection
      5) Cooler setpoint
      6) Chilled water reset parameters
      7) Thermistor and transducer malfunction
      8) Entering and leaving-fluid temperature
      9) Compressor suction temperature
      10) Evaporator and condenser pressure
      11) System refrigerant temperatures
      12) Chiller run hours
      13) Compressor run hours
      14) Compressor number of starts
      15) Low superheat
6. Safeties: unit protected against the following:
   a. Loss of refrigerant charge
   b. Reverse rotation
   c. Low chilled water temperature
   d. Low oil pressure
   e. Voltage imbalance
   f. Ground current fault
   g. Thermal motor overloads
   h. High pressure
   i. Electrical overload

j. Loss of phase
k. Current imbalance

I. Electrical:
1. Single point electrical connection
2. Factory-installed 115V control power transformer
3. Factory-installed 115V GFI receptacle
4. Shipped with factory control and power wiring installed.
5. Main power supply disconnect: None. Disconnect provided by Division 26.

J. Accessories:
1. Vibration Isolators: for field installation
2. Acoustic Enclosure: provide for each compressor.
3. Remote Supply Temperature Reset: 4 to 20 mA signals for leaving fluid temperature setpoint reset.

K. Capacity: As scheduled on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install chiller and make piping connections as recommended by manufacturers.

B. Install differential pressure switch and provide necessary interlock wiring.

C. Install necessary piping wells provided by manufacturer.

3.02 ADJUSTMENT

A. After installation is complete, arrange for start-up with factory technician.

3.03 INSPECTION START-UP, AND TRAINING

A. Inspection start-up, and training provided by factory trained and authorized representative employed by manufacturer or supplier of equipment specified. Representative shall routinely provide start-up and training services required. Services provided shall include:
1. Pre-functional check of equipment to ensure installation has been performed in complete accordance with manufacturer's recommendation. Provide pre-functional check forms to Engineer and Owner for approval.
2. Equipment start-up as recommended by manufacturer.
3. Six (6) hours of operator training specific training agenda and schedule as required by Owner-developed training plan.

END OF SECTION

SECTION 23 65 13.16

CLOSED-CIRCUIT, FORCED-DRAFT COOLING TOWERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
1. Factory-assembled, closed-circuit, forced-draft cooling towers.

1.02 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Maximum flow rate.
3. Minimum flow rate.
4. Pressure required at cooling tower supply piping connections.
5. Fan motor electrical characteristics, including but not limited to, speed, voltage, phase hertz, amperage, efficiency, and power factor.
6. Pump flow rate, head, brake horsepower, and efficiency.
7. Pump motor electrical characteristics, including but not limited to, speed, voltage, phase hertz, amperage, efficiency, and power factor.
8. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings:
1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Diagram showing each separate piece requiring field assembly.
4. Shipped sub-assembly dimensions and weights for field assembly.
5. Assembled unit weight without water.
6. Operating weight and load distribution.
7. Unit vibration isolation and seismic controls.
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.
   1. Clearly label each package with a unique designation and include assembly instructions for each complete cooling tower.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following: Evapco, Baltimore Aircoil Company, Marley, or approved.

2.02 PERFORMANCE REQUIREMENTS

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 use.

B. Vibration:
   1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry-standard requirements for cooling towers.
   2. Critical speed shall be at least 115 percent of design speed.

2.03 DESIGN ARRANGEMENT

A. Counterflow pattern with inlet airflow from one side and forced-draft, bottom-mounted, centrifugal fans; and with pressurized pipe distribution near top.

2.04 CASING AND FRAME

A. Casing Material: Galvanized steel, ASTM A 653/A 653M, G235 coating.

B. Frame Material: Galvanized steel, ASTM A 653/A 653M, G235 coating.

C. Hardware/fasteners: stainless steel.

D. Joints and Seams: Sealed watertight.

E. Welded Connections: Sealed watertight.

2.05 COLLECTION BASIN

A. Factory-Assembled Collection Basin:
   1. Material: Galvanized steel, ASTM A 653/A 653M, G235 coating or polymer-coated galvanized steel.
   2. Hardware: Galvanized or stainless steel.
   3. Joints and Seams: Sealed watertight.
   4. Welded Connections: Sealed watertight.
   5. Removable stainless-steel strainer with openings smaller than nozzle orifices.
   6. Overflow and drain connections.
   7. Makeup-water connection.
   8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.

2.06 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

A. Electronically Operated, Collection Basin Water-Level Control:
   1. NEMA 4X enclosure.
   2. Three stainless steel level sensors:
      a. High level
      b. Low Level
      c. Ground
   3. Slow closing solenoid valve and wye-strainer.
   4. Cleanable standpipe.

2.07 COLLECTION BASIN SWEEPER

A. Collection basin shall be factory fitted with Sch 80 PVC sump sweeper piping complete with high-flow eductor nozzles to facilitate basin cleaning.

2.08 COLLECTION BASIN HEATER

A. Electric Heater:
   1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
   2. Heater Control Panel: Mounted on the side of each cooling tower cell.
   3. Enclosure: NEMA 250, Type 3R or Type 4.
   4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
   5. Control-circuit transformer with primary and secondary side fuses.
   6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
   7. Single-point, field-power connection to a fused disconnect switch and heater branch circuiting complying with NFPA 70.
   8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures; except, connections to each electric basin heater shall be liquid-tight conduit.
      a. Raceway shall be corrosion-resistant stainless steel or PVC-coated steel.

2.09 PRESSURIZED DISTRIBUTION NETWORK

A. Main header and lateral branch piping designed for even distribution over fill and heat-exchanger coils throughout the entire flow range without the need for balancing valves and for connecting individual, easily removable, non-clogging spray nozzles.

B. Pipe Material: Schedule 40 PVC.

C. Spray Nozzle Material: Plastic, Polypropylene or PVC.

D. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

2.10 HEAT-EXCHANGER COILS

A. Tube and Tube Sheet Materials: Copper tube with stainless-steel tube sheet, stainless-steel tube and tube sheet or carbon-steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication.

B. Heat-Exchanger Arrangement:
   1. Serpentine tubes or straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube; and sloped for complete drainage of fluid by gravity.
   2. Tubes with extended surface fins if required to achieve performance indicated.

3. Multiple Separate Circuits: Separate circuits to achieve multiple isolated loops as required by application.

C. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.

D. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.

2.11 DRIFT ELIMINATORS

A. Material: PVC, with maximum flame-spread index of 25 according to ASTM E 84.

B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

C. Arrangement: Multiple, easily removable sections.

D. Configuration: Multi-pass, designed and tested to reduce water carryover to 0.001 percent of design flow rate indicated.

E. Hardware: Stainless-steel.

2.12 AIR INLET

A. Removable Air-Intake Screens:
1. Galvanized Polymer-coated, galvanized or Stainless-steel wire mesh, with openings of size sufficient to not restrict airflow or impact performance.
2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.

B. Hardware: Galvanized or stainless steel.

2.13 FAN AND DRIVE ASSEMBLY

A. Centrifugal Fans: Double-width, double-inlet, forward-curved blades; statically and dynamically balanced at the factory after assembly.
1. Cooling Tower Cell Fan Assembly: Each cooling tower cell shall have a single fan or multiple fans connected to a common shaft.
2. Fan Wheel and Housing Materials: Hot-dip galvanized steel.
3. Fan Shaft: Steel, coated to resist corrosion.
4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300°F. Bearings designed for an L-10 life of 40,000 hours.
5. Bearing Grease Fittings: Extended lubrication lines to an easily accessible location.
6. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.

B. Belt Drives:
1. Service Factor: 1.5 based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt: Multiple V-belt design with a matched set of belts.
4. Belt: One-piece, multi-grooved, solid-back belt.
5. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.
6. Belt-Drive Guard: Comply with OSHA regulations.

C. Fan Motors: Provided hereunder. See Section 23 0513 “Common Motor Requirements for HVAC Equipment.”.

D. Fan Variable-Frequency Drive: Provided hereunder as scheduled, refer to SECTION 23 05 14 - MOTOR CONTROL DEVICES FOR MECHANICAL EQUIPMENT.

E. Hardware: Stainless steel.

2.14 RECIRCULATING-WATER DISTRIBUTION SYSTEM

A. Pump: Close-coupled, single-stage, bronze-fitted centrifugal pump with mechanical seal; suitable for outdoor service. Factory install pump with following:
1. Redundant Pump: Same performance as required for primary pump; easily switched and maintained while cooling tower remains operating.
2. Flanges at pump connections to piping.
3. Strainer, with blowdown isolation valve, installed in piping on suction side of pump.
4. Flow-balancing valve in piping on discharge side of pump.

B. Pump Motor:
1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium induction motor.
3. 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.
4. Motor Enclosure: Open drip-proof or totally enclosed and with epoxy or polyurethane finish.
5. Rotor: Random wound, squirrel cage.
6. Energy Efficiency: Comply with ASHRAE/IES 90.1 NEMA Premium Efficient.
7. Service Factor: 1.15.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Severe-Duty Rating:
    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F
    c. Internal Heater: Automatically energized when motor is de-energized.
    d. Complying with IEEE 841.

C. Spray Pump Motor Starter: Provided hereunder as scheduled, refer to SECTION 23 05 14 – COMMON MOTOR CONTROL DEVICES FOR HVAC EQUIPMENT.

D. Piping: Interconnecting collection basin to pump and pressurization distribution system.
1. Design delegated to manufacturer.
2. External to and supported from cooling tower casing and frame.
3. Material: Corrosion-resistant PVC.
4. Install flanges at connections to collection basin and pressurized distribution system.
5. Drain connection with isolation valve at piping low point if piping does not drain directly into collection basin.

E. Piping: Field installed for connection to remotely installed pump and water storage that are not furnished with cooling tower.

2.15 SERVICE ACCESS

A. Doors:
1. Large enough for personnel to access cooling tower internal components.
2. Doors shall be hinged with handles operable from both sides of the door.
3. Door materials shall match casing.

4. Hinges and handles shall be corrosion-resistant.

B. Service ladder:
1. Aluminum, 1'-6" wide ladder with 3" I-beam side rails and 1.25" diameter serrated rungs shall extend from the base of the tower to the top of the unit for motor access.

C. Hardware: Galvanized steel when connecting galvanized-steel components and stainless steel when connecting other materials.

2.16 WATER TREATMENT

A. Refer to Section 23 25 13 “Water Treatment for Hydronic Systems”.

2.17 CAPACITIES AND CHARACTERISTICS

A. As scheduled on Drawings.

2.18 ELECTRICAL POWER AND CONTROLS

A. Electrical:
1. Single-point, field-power connection to a fused disconnect switch circuit breaker.
   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
2. Factory Furnish Field Control Panel contain all electrical power components.
3. Provide factory installed wiring for the following components:
   a. Collector basin heater, with disconnect
   b. Controls transformer to 120VAC

B. Controls
1. Vibration cutout switch, DPDT.
2. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
3. Electric basin heater temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
4. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor.
5. Factory-installed wiring outside of enclosures shall be in metal raceway; except, make connections to each motor and electric basin heater with liquidtight conduit.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.
1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.
3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install cooling towers on support structure.

B. Equipment Mounting:
   1. Install cooling towers on base rails, as detailed on Drawings.

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Loose Components: Install components, devices, and accessories including ladders furnished by manufacturer with cooling tower that are not factory mounted.

G. Field Wiring:
   1. Provide field wiring under this section for the following:
      a. Vibration switch
      b. Makeup water solenoid
      c. Heater low water cutoff
   2. Field wiring provided by Division 26 for the following:
      a. Fan variable frequency drive power, and conductors to fan motor.
      b. Sump heater wiring.
      c. Spray pump motor wiring.

3.03 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Install drain piping with valve and hose connection at cooling tower drain connections and at low points in piping.

E. Provide tower collector basin cross-over piping as required.

3.04 ELECTRICAL POWER CONNECTIONS

A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

B. Install 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.

3.05 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.07 STARTUP SERVICE

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

B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.
   1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      a. Clean entire unit, including basins.
      b. Verify that accessories are properly installed.
      c. Verify clearances for airflow and for cooling tower servicing.
      d. Check for vibration isolation and structural support.
      e. Lubricate bearings.
      f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
      g. Verify pump rotation for correct direction, vibration, cavitation, and flow, and correct problems.
      h. Adjust belts to proper alignment and tension.
      i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
      j. Check vibration switch setting. Verify operation.
      k. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
      l. Verify operation of basin heater and control.
      m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
      n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.08 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

C. Adjust basin heater control for proper operating setpoint.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.
   1. Video record the training sessions.
   2. Instructor shall be factory trained and certified.
   3. Perform not less than two hours of training.
   4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
   5. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

6. Obtain Owner sign-off that training is complete.
7. Owner training shall be held at Project site.

END OF SECTION

SECTION 23 82 16

AIR COILS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
1. Hydronic cooling air coils.
2. Steam air coils.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities and operating characteristics including:
a. Tube water velocity for hydronic coils
b. Pressure drops for each air coil.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Selection Criteria:
1. Hydronic Coil Tube Velocity: Coils shall be selected with appropriate tube water velocity to ensure acceptable performance at low load conditions. Coils tube water velocity at rated operating conditions shall be shall equal to or greater than the following, except where limited by minimum tube diameter:
a. Chilled water coils: 3.0 feet per second.
2. Hydronic Coil Water Pressure Drop: Coils shall be selected for a maximum water pressure drop as follows, except pressure drop is scheduled on Drawings:
a. Chilled water cooling coils: 15 feet water column.

2.02 HYDRONIC COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aerofin.
2. Carrier Corporation; a unit of United Technologies Corp.
3. Colmac Coil Manufacturing, Inc.
4. Greenheck Fan Corporation.
5. Heatcraft Worldwide Refrigeration.
6. Trane.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325°F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum thickness 0.025 inch for tubes 5/8" and larger, 0.020inch for 1/2-inch tubes.

F. Fins: Aluminum, minimum 0.0075 inch thick.

G. Headers:
1. Copper runout piping or for open loop systems with untreated water sources such as city potable water or well systems: Seamless copper tube with brazed joints, prime coated or cast iron with cleaning plugs and drain and air vent tappings.
2. Steel runout piping in closed loop systems: Steel with brazed joints, prime coated or cast iron with drain and air vent tappings.

H. Chilled-Water Coil Capacities and Characteristics:
1. Coil Face Dimensions: As scheduled on Drawings or as required to achieve scheduled performance.
2. Minimum Fin Spacing: 0.083 inch.
3. Tube Diameter: As required to achieve scheduled performance.
   a. Air handling equipment mounted coils: Minimum 0.50 inch.
4. Number of Rows: As scheduled on Drawings.
5. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick.
6. Mounting: Flanged.
7. Performance: As scheduled on Drawings.

2.03 STEAM COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aerofin.
2. Carrier Corporation; a unit of United Technologies Corp.
3. Colmac Coil Manufacturing, Inc.
4. Greenheck Fan Corporation.
5. Heatcraft Worldwide Refrigeration.
6. Trane.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 100 psig, 400°F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.025 inch thick.

F. Fins: Aluminum, minimum 0.0075 inch thick.

G. Headers: Cast iron with drain and air vent tappings or steel with brazed joints, prime coated.

H. Capacities and Characteristics:
1. Coil Face Dimensions: As scheduled on Drawings or as required to achieve scheduled performance.
2. Minimum Fin Spacing: 0.083 inch.
3. Tube Type: Distributing
4. Tube Diameter: As required to achieve scheduled performance.
   a. Distributing coils: 3/8-inch steam distributing tubing installed concentrically in one-inch OD condensing coil tubes.
5. Number of Rows: As required to achieve scheduled performance.

6. Frames: Galvanized-steel channel frame, minimum 0.064 inch thick
7. Mounting: Flanged.
8. Performance: As scheduled on Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible.

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

E. Seal joints to eliminate air bypassing coil or leakage from ductwork at coil piping and drain connections.

3.03 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping.

END OF SECTION

SECTION 26 01 55

ELECTRICAL SYSTEMS FIRESTOPPING

PART 1 – GENERAL

1.01 SCOPE

A. Section includes requirements for through-penetration fire stopping for items including, but not limited to, conduit and cable tray provided under Divisions 26, 27, and 28.

B. Section also includes requirements for recessing fixtures, cabinets, or devices in fire rated walls, ceilings, and floors.

C. Products shall be of a single manufacturer for each type of fire stopping required, and where several types are integrated into a single assembly. Provide putty sealants, wraps, boards, and accessories as necessary and required for the work of this project.

1.02 REFERENCES

A. Underwriters Laboratories:
1. UL Fire Resistance Directory
2. UL Component Listing Test Criteria
3. Warnock Hersey

B. American Society for Testing and Materials Standards:
1. ASTM E 814 – 88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

C. International Building Code, current edition, with State of Washington Amendments – Chapter 7 Fire Resistance Rated Construction.

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Fire Stopping Assemblies		X		X				
Accessories		X		X				

1.04 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to a given type of construction.

B. Barriers: Time rated fire walls, ceiling/floor assemblies, and structural floors.

C. Fire Stopping: Assembly of materials applied at penetrations to limit spread of heat, fire, gases, and smoke.

D. Penetration: Opening through or into a barrier such the full thickness of rated materials is not obtained.

E. System: Specific products and applications, classified and numbered by Underwriters Laboratories (UL), Inc. to close specific barrier penetrations.

F. F Rating: Time period that fire stop assembly can withstand fire and hose stream test as determined in UBC Standard 7-5.

G. T Rating: As required for F Rating and to limit temperature rise above initial temperature to 325°F on protected sides as determined in UBC Standard 7-5.

1.05 SHOP DRAWINGS, PRODUCT DATA, OPERATION & MAINTENANCE DATA

A. Provide manufacturer's installation drawings and instructions for each proposed assembly. Identify intended product and applicable UL System number or UL classified devices.

B. Provide manufacturer recommendations and drawings relating to non-standard applications where necessary.

1.06 QUALITY ASSURANCE

A. Installer Qualification: Acceptable to, or certified by, fire stopping system manufacturer.

B. Regulatory Requirement: Contractor shall verify acceptance from Authority Having Jurisdiction for proposed assemblies conforming to, or not conforming to, specific UL Fire Stop System Numbers, or UL classified devices.

C. Products shall comply with the requirements of Oregon Revised Statute (ORS) 453.005 (7) (e), effective January 1, 2011. The referenced statute limits the use of three types of brominated fire-retardant chemicals, which are defined as hazardous substances.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in original, unopened packaging with legible manufacturer's identification. Store materials in accordance with manufacturer's instructions. Store in clean, dry, ventilated location, protected from freezing.

1.08 WARRANTY

A. Submit copies of written warranty for fire stopping assemblies. Warranty period shall be one-year minimum.

PART 2 – PRODUCTS

2.01 GENERAL

A. Fire Stop products and accessories shall be asbestos-free, intumesce when exposed to temperatures of 250°F, and maintain an effective barrier against flame, smoke and gases. Mortar systems must be Warnock Hersey approved.

B. Fire Stop Fire Rating: Not less than the rating of barrier penetrated in which fire stopping will be installed.

2.02 FIRESTOPPING ASSEMBLIES

A. Assemblies of materials used to seal spaces around penetrations shall have a UL Fire Stop System Number appropriate for the construction type, penetration type, annular space requirements, and fire rating at each penetration.

B. Systems and devices must withstand the passage of cold smoke either as an inherent property of the system or by the use of a separate product included as part of the UL system or devices and designed to perform this function. Systems complying with the requirements for through-penetration firestopping in fire-rated construction are acceptable provided the system will provide a smoke seal.

C. Performance Requirements: Fire stop assembly shall be able to withstand standard fire and hose stream test (F Rating) and limit temperature rise (T Rating) of penetrations on protected side as required by Authorities Having Jurisdiction. Conform to IBC Chapter 7.

D. Manufacturers: 3M, Dow, Chase Technology Corp., Bio Fireshield Inc., Johns Manville, Specified Technologies Inc., Metacaulk, GS Hevi-Duti/Nelson, or approved.

2.03 ACCESSORIES

A. Fill, void, or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.

B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.

PART 3 – EXECUTION

3.01 GENERAL

A. Provide fire stopping seal at cable tray, wiring, or conduit penetration, installed under Divisions 26, 27 and 28, through fire rated construction.

B. Provide fire rated assembly around electrical devices, panelboards, outlet boxes, back boxes, cabinets, and luminaires recessed in fire rated walls and ceilings. See Architectural drawings for locations of fire rated walls and ceilings.

C. Verify barrier penetrations are properly sized and in suitable condition for application of materials.

D. Provide masking and drop cloths to prevent contamination of adjacent surfaces by fire stopping materials. Clean spills of liquid components. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

E. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance. Cut and trim materials as required to neatly match edges of penetration.

F. Comply with manufacturer’s recommendations for temperature and humidity conditions before, during, and after installation of fire stopping.

END OF SECTION

SECTION 26 05 00

GENERAL ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.01 CONTRACT DOCUMENTS

A. General electrical provisions apply to all work performed in Division 26, 27, and 28.

B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.

C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.

D. Particular attention is called to Instructions to Bidders, General Conditions, Drawings and Specifications, and modifications incorporated in the documents before execution of the Agreement.

E. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.

F. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

G. Use of the word "Provide" shall be equivalent to "Furnish and Install."

1.02 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): The governmental agency or sub-agency which regulates the construction process.

B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

1.03 COORDINATION

A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and Owner's Authorized Representative and secure written approval and agreement on necessary adjustments before start of work.

B. Architectural drawings govern all other drawings. Consult in detail the door swings, counter heights and similar items affecting work before rough-in.

C. Coordinate identification systems with other trades. All electrical systems shall use identical wiring, conduit, and equipment identification and regulatory signage.

1.04 SUBMITTALS AND SHOP DRAWINGS

A. See Section 01 33 23 "Shop Drawings, Product Data, and Samples."

B. Action Submittal Content

1. Action submittal information not expressly required by the specifications will not be reviewed.
2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
4. Action submittal requirements are listed in individual specification sections. The following definitions apply.
    a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
    b. Catalog data: Manufacturer's standard product cut sheet.
    c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.
    d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
    e. Wiring Diagrams: Power and control wiring diagrams.
    f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
    g. Installation Instructions
    h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

C. Delegated Design
1. Delegated work will include but is not limited to the following:
    a. Section 26 05 48 "Seismic Control for Electrical Systems."
    b. Section 28 31 00 "Fire Alarm System."
2. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
    a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer and Owner.
3. Delegated-Design Services Certification: In addition to shop drawings, product data, and other required submittals, submit digitally signed PDF electronic file, three, paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
    a. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

D. Sustainable Design Requirements
1. See Section 01 81 13 " Sustainable Design Requirements" for procedures used to establish compliance with the US Green Building Council LEED prerequisites and credits established for the project.

1.05 QUALITY ASSURANCE

A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.

B. Asbestos products or equipment or materials containing asbestos shall not be used.

C. Certify that each welder has passed the American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

1.06 DESIGN REQUIREMENTS

A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.

B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

1.07 CODES AND STANDARDS

A. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.

B. Work shall comply with the Americans with Disabilities Act (ADA).

1.08 TEMPORARY SERVICES

A. Provide in accordance with Section 01 50 00 "Temporary Facilities and Controls" as required for completion of work. Provide additional filters as required to keep areas clean during construction.

B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

1.09 OPERATIONS AND MAINTENANCE MANUALS

A. Bind manuals in three-ring, high quality vinyl covered binders, clearly indexed and provided with thumb tabs for each item or product. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each. Index tabs shall match submittal schedule and include any additional information required for operations and maintenance, whether in submitted schedule or not.

B. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.

C. Provide copy of approved submittal for each product included in manual

D. Provide printed copy and electronic configuration files for all packaged equipment control systems furnished with equipment.

E. Mark the model actually provided where the literature covers more than one model. Include four copies of all submittal data corrected to "as-built" conditions within the manual.

F. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.

G. Manual Content: Manuals shall contain complete information for each item of mechanical electrical or other operating equipment. Include as applicable:
1. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance
2. Performance capacity
3. Catalog data sheets
4. Parts list
5. Maintenance schedules

1.10 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Alternately, provide electronically using .pdf markup of contract drawings.

1.11 DEMONSTRATION

A. General: After installation is complete, demonstrate to Engineer and Owner’s Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.

B. Preparation: Prior to demonstration, submit check-off list indicating completeness of submittals and certificates of compliance for review to Owner’s Authorized Representative. Operate completed system for one week. Verify that control verification is complete and verification report has been approved by Architect/Engineer and Owner.

C. Arrange for demonstration with Owner, Engineer, required factory technicians, and installer at least one week in advance of demonstration.

1.12 TRAINING

A. Instruct Owner in proper operation and maintenance of equipment and systems. Instruction shall generally include topics listed in manufacturer’s operations and maintenance manual. Operator instructions shall cover all aspects of manual, automatic, and safety controls. Contractor shall also instruct the Owner in the general configuration of systems and location of equipment and components.

B. Furnish competent qualified technicians knowledgeable in the building electrical and lighting systems and equipment provided for this project for a minimum of 16 hours on-site to instruct Owner in operation and maintenance of systems and equipment. This figure does not include additional training noted under individual specification sections. Contractor shall keep a log of this instruction including date, times, subjects, and those present and shall present such log when requested by Engineer. Contractor shall coordinate training with Owner’s Project Manager and provide a schedule for training minimum two-weeks prior to Substantial Completion. All training shall be complete 30-days after Substantial Completion.

C. Contractor shall furnish training by equipment manufacturers in addition to training described in this section where specifically listed in other sections. Contractor shall schedule training with Owner's Project Manager minimum 48-hours prior to training session. Equipment shall be fully operational prior to scheduling training session. Manufacturer's field start-up, adjustment, and service will not fulfill manufacturer's training requirement.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS

A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.

B. Equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.'

2.02 ELECTRICAL EQUIPMENT

A. Electrical Disconnect Switch: Electrical disconnect switches specified for mechanical equipment shall conform to OSHA Lock-out/Tag-out requirements.

B. All electrical equipment shall be listed as approved for its application by the Underwriters Laboratory or other testing agency approved by the State of Oregon.

C. Enclosure: Provide the following electrical equipment enclosure types.
1. NEMA 1: Dry, enclosed locations where the ambient temperature will not be outside of the equipment temperature ratings.
2. NEMA 12: Enclosed mechanical spaces equipped with floor drains where dripping or splashing may occur and where the ambient temperature will not be outside of the equipment temperature ratings.
3. NEMA 3R: Outdoors or in spaces where sustained water spray is possible.
4. NEMA 3R: with Temperature Control: Outdoors or in unconditioned spaces where ambient temperatures will be outside of the equipment temperature ratings.
5. NEMA 4X: Outdoors or in spaces that are corrosive environments

2.03 EQUIPMENT CONNECTIONS

A. Provide a complete electrical connection for all items of equipment including incidental wiring, materials, devices and labor necessary for a complete operating system. The location and method for connection to each item of equipment shall be verified prior to rough-in. The voltage and phase of each item of equipment shall be checked prior to connecting. Motor rotations shall be made in the proper direction. Pump motors are not to be test run until liquid is in the system and proper lubrication to all bearings in unit is checked.

B. Conduit, wire and circuit breaker sizes for mechanical and similar equipment are based on the equipment ratings of one manufacturer. The equipment actually furnished may have different electrical characteristics. Conduit, wire, and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. The Contractor is responsible for this coordination.

2.04 FIRESTOPPING

A. See Section 07 84 00 “Firestopping”

2.05 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Acceptable Manufacturers: J.L. Industries, Karp Associates, Inc., Meadowcraft, Inc., Milcor Div.; Inryco, Inc., or Nystrom, Inc.

B. Application: Match access door to wall or roof assembly fire rating.

C. Access Door Assembly: Continuous welded steel construction unless otherwise indicated. Grind exposed welds smooth and flush with adjacent surfaces. Provide anchors and attachments necessary for installation indicated.
1. Frames: 16 gage steel; provide flange type necessary for the installation required.
2. Stainless Steel Frames and Flush Panel Doors: 14 gage stainless steel, No. 4. satin finish; concealed spring hinges or concealed piano hinge set to open 175 degrees.
3. Flush Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees
4. Lock: Screwdriver-operated cam locks, number required to hold door flush when closed.
5. Ceiling Doors: Recessed door panel depth necessary to finish ceiling insert and install flush to adjacent finish ceiling. Reinforced 18 gage sheet steel face. Provide access sleeves for locking devices. Size: As necessary for efficient access, but not less than 24 by 24 inches. Obtain Architect's/Engineer’s acceptance of manufacturer's standard size units which vary from sizes indicated.

D. Fire Rated Units: Comply with NFPA 80, provide UL listed and labeled units having performance level required with insulated flush panel door, continuous piano hinge and self-closing mechanism for rated assemblies in sizes and configuration required.
1. Vertical Doors: NFPA 252 or UL 10B.
2. Horizontal Doors: ASTM E 119 or UL 263.

E. Shop Applied Coating: Corrosion resistant prime paint compatible with field applied finish specified in Section 09 91 23 “Interior Painting”.

F. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 tested according to the following test method:
1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
2. NFPA 288 for fire-rated access door assemblies installed horizontally.

PART 3 - EXECUTION

3.01 ACCESS TO EQUIPMENT AND ACCESSORIES

A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for junction & pull boxes, relays & power packs, and all other electrical equipment requiring access for removal or maintenance. Type, size and exact location of access doors shall be coordinated with Architect/Engineer and Owner prior to Work.

B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer’s recommendations, provide larger clearance of the two.

C. If equipment location shown on Drawings does not allow required access, notify Architect/ Engineer and Owner prior to start of work.

D. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to Architect/Engineer for resolution prior to starting work.

E. Provide access doors as required for access to electrical equipment. Doors required for access are not necessarily shown on Drawings. Consult with Architect/Engineer for direction on placement of required doors not shown on Drawings.
1. Comply with manufacturer's instructions for installation of access doors. Provide all necessary support and supplemental framing for assembly where the access doors are required. Set accurately in position, plumb, level, and flush to adjacent finish surfaces; and secure to support.

3.02 ARRANGEMENT AND INSTALLATION OF ELECTRICAL EQUIPMENT AND CONDUIT

A. Coordinate location of conduit, sleeves, inserts, hangers, cable trays and equipment. Locate conduit, sleeves, inserts, hangers, cable tray and equipment clear of windows, doors, openings, lights, ducts, piping, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Equipment and Conduit Support: Coordinate structural systems necessary for conduit and equipment support with pipe and equipment locations to permit proper installation.

C. Location of conduit sleeves, trenches and chases shall be accurately coordinated with equipment and conduit locations.

D. Minor Conduit: Small diameter conduit runs from receptacles, lighting, equipment, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor conduit where needed to maintain electrical spaces clean and neat and to allow full equipment function and maintenance.

E. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner's Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Architect/Engineer's and Owner's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

F. Inaccessible Equipment
1. Where the Owner's Authorized Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.03 RIGGING

A. Design is based on use of available structure without modification except as specifically shown. Existing openings in building structures are planned to accommodate design scheme.

B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Architect/Engineer and Owner under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.

C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Owner's operation and maintenance.

D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Where it is not clear that the building structure has adequate capacity to support rigging, Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to existing building structure, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

E. Restore building to original condition upon completion of rigging work.

3.04 EXISTING EQUIPMENT REUSED OR RELOCATED

A. All equipment designated as existing or furnished by Owner shall be cleaned and repaired before reinstallation. Any items requiring repair shall be brought to the attention of the construction manager before the item is reinstalled. Damage not brought to the attention of the construction manager shall be deemed the result of reinstallation of the item and shall be repaired without expense to the Owner.

3.05 ELECTRICAL SYSTEMS FIRESTOPPING

A. Do not cover firestop installations until they are examined by the Authority Having Jurisdiction, if required.

B. Install firestopping in accordance with manufacturer's recommendations and conditions of product UL listing.

3.06 CLEANING SYSTEMS

A. General: After all equipment, conduits and cable tray are installed, system shall be thoroughly cleaned. Remove all nonessential stickers and labels from equipment or fixtures. Clean all light fixture lenses. Clean interior of conduit systems prior to installation of wiring.

B. Repair or replace any discolorations or damage to systems, building finish, or furnishings resulting from Contractor's failure to properly clean system.

3.07 START UP

A. The Electrical Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.

B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated breakers, relays, , electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.

3.08 EXTRA STOCK

A. Provide extra stock, as described in individual sections, to Owner in accordance with Division 1.

END OF SECTION

SECTION 26 05 01

ELECTRICAL DEMOLITION

PART 1 – GENERAL

1.01 SCOPE

A. It is the intent of these documents to provide the necessary information and adjustments to the electrical system required to meet Code and accommodate installation of the new work.

B. Contractor shall coordinate with the Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas. The Owner will cooperate to the best of their ability to assist in a coordinated schedule but will remain the final authority as to time of work permitted.

1.02 EXISTING CONDITIONS:

A. The locations of existing utilities and equipment are shown in an approximate way only and have not been independently verified by the Owner or its representative. The Contractor shall determine the exact location of all existing utilities before commencing work and agrees to be fully responsible for any and all damages which might be occasioned by the Contractor's failure to exactly locate and preserve any and all utilities and equipment. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on the Drawings.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All materials accumulated during the demolition process are the Owner's property and shall be removed from the job site as directed by the Owner.

PART 3 – EXECUTION

3.01 DEMOLITION

A. Remove all existing fixtures, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless specifically shown as retained or relocated on the Drawings.

B. Disconnect all existing mechanical equipment scheduled for removal, relocation or abandonment. See mechanical Drawings for scope of work. Remove abandoned cables and unusable raceways. Relabel panels and motor control centers to reflect changes.

C. Maintain electrical continuity of all existing systems. Remove or relocate electrical boxes, conduit, wiring, equipment, fixtures, etc. as may be encountered in removed or remodeled areas in the existing construction affected by this work. Wiring which serves usable existing outlets shall be removed and restored clear of the construction or demolition. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, new conduit and wire shall be provided to bypass the abandoned outlets. If existing conduits pass through partitions or ceiling which are being removed or remodeled, new conduit and wire shall be provided to reroute clear of the construction or demolition and maintain service to the existing load.

D. Existing electrical outlets and light fixtures are denoted by dotted or dashed lines. Verify exact location of existing electrical outlets and light fixtures in the field. Only partial existing electrical shown. Locations of items shown on the Drawings as existing are partially based on as-built and other drawings which may contain errors. The contractor shall verify the accuracy of the information shown prior to bidding and provide such labor and material as is necessary to accomplish the intent of the contract documents.

E. Remove all abandoned wiring to leave site clean.

F. Keep outages to occupied areas to a minimum and prearrange all outages with the Owner's representative. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specific dates and hours and the maximum durations. This Contractor will be liable for any damages resulting from un-scheduled outages or for those not confined to the preapproved times. Outages shall take place at times when the facility is not in operation or occupied by non-essential personnel. Include all costs for overtime labor as necessary to maintain electrical services in the initial bid proposal. Temporary wiring and facilities, if used, shall be removed and the site left clean before final acceptance. Requests for outages must be submitted at least (5) days prior to intended shutdown time.

G. No circuit breaker or disconnects shall be turned off without prior approval from Owner. Coordinate with the Owner's representative responsible for the area or equipment affected for any electrical interruptions which affect the operation of the remaining portions of the facility.

H. Verify with the General Contractor a location for storage of materials, supplies, tools, rubbish, etc. prior to start of work.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wires and Cables

B. Wire Connections

1.02 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)
1. NFPA 70 National Electrical Code

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – Common Work Results for Electrical. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein

PRODUCT TABLE	1	2	3	4	5	6	7	8
Conductor and cable materials		X						
Twist-on connector		X						
Compression adapter		X						
Terminal, crimp on		X						

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver new wire to Site in new standard coils or reels with approved tag denoting length, wire size, insulation type and manufacturer's name.

B. Protect from weather and damage during storage and handling.

PART 2 - PRODUCTS

2.01 CONDUCTOR AND CABLE MATERIALS

A. Building Wiring: 98 percent conductivity copper, 600-volt insulation, stranded. Type THHN for interior dry and damp locations. Type THWN or XHHW for wet and exterior locations.

B. Branch Circuit Wiring: Conductors smaller than No. 12 AWG for power system branch circuits not permitted.

C. Motor control wires shall be No. 14 minimum.

D. Wire for special areas shall be as specified on the Drawings.

2.02 TWIST-ON CONNECTOR

A. UL pressure-type, solderless, insulated, wound spring grip twist on connector.

B. Solderless pressure connectors for terminals, taps, and splices.

2.03 COMPRESSION ADAPTER

A. For terminating a single aluminum wire into mechanical connectors, such as a circuit breaker or set screw lugs. Burndy "Hyplug" Type AYP, or approved equal by Anderson, Illsco, Kearney, Mac-Adapt, T&B.

2.04 TERMINAL, CRIMP-ON

A. Flat, fork tongue, self-insulating.

B. For connection of stranded wire to screw terminals.

C. T & B "Sta-Kon," or approved equal.

PART 3 - EXECUTION

3.01 CONDUCTOR AND CABLE INSTALLATION

A. Make conductor length for parallel feeders identical.

B. Lace or clip groups of feeder conductors at distribution centers, pullboxes, and wireways.

C. Provide copper grounding conductors and straps. A ground wire shall be pulled through conduits and used as the equipment grounding conductor.

D. Use 10 AWG conductor**s** for 20 ampere, 120-volt branch circuit home runs longer than 100 feet, and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet. Neutral conductor shall be sized the same as corresponding “hot” conductors.

E. No shared neutrals. Provide one neutral for each phase conductor in branch circuits.

F. Wire and cable shall be brought to the job in the original containers bearing the U.L. label.

G. Install wire and cable in code conforming raceway.

H. Use wire pulling lubricant for pulling No. 4 AWG and larger wire. UL approved type only.

I. Install wire in conduit runs after concrete and masonry work is complete and after moisture is swabbed from conduits.

J. Couplings and conduit connectors shall have pre-insulated bushings in place before pulling wires.

K. Splice only in accessible junction or outlet boxes. Splice in feeders and services not permitted. Splices or taps in branch circuits permitted only in junction boxes where circuits divide.

L. Color code conductors to designate neutral, phase, and ground as follows:

CONDUCTOR	120/208 OR 120/240	277/480
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Switchlegs	Pink	Pink
Travelers	Purple	Purple
Fire Alarm	Red	
Intercom/Clock/Bell	Grey	
Security	Orange	
HVAC Control	Green	
Data/Telecom	White (CAT6)	

M. Wires shall be factory color coded by integral pigmentation. Colored plastic tape permitted on No. 6 and larger where integral pigmentation impractical. Apply tape in spiral half-lap over exposed portions in manholes, boxes, panels, switchboards and other enclosures.

N. All circuit conductors shall be identified with circuit number at all terminals, intermediate outlets, disconnect switches, circuit breakers, motor control centers, etc. Both ends of a given conductor shall be identified alike.

O. DO NOT install wires of different voltage systems in same raceway, box, gutter or other enclosure.

P. Radius of cable bends shall not be less than 10 times the outer diameter of the cable.

Q. Megger test all power conductors except as specified in manufacturer’s instructions. Maintain megger sheets for all insulation tests conducted and megger readings per manufacturer’s instructions. (ASI-04)

3.02 CONNECTIONS AND SPLICES

A. Follow manufacturer's instructions using manufacturers recommended tools.

B. Stripping Insulation: Carefully strip, avoid nicking conductor. No "ringing."

C. Design: Connectors shall be designed and approved for the purpose used. Connectors between aluminum and copper shall be listed "AL/CU" for the purpose of preventing electrolytic action.

D. Bare Connectors and Conductor Free Ends: Wrap with insulating rubber or friction tape to equivalent insulation of wire.

E. Ground Continuity to Metallic Surfaces: Remove any paint coating and polish surface beneath connection.

F. Copper conductors may be terminated in any approved compression or mechanical connector, including set screws.

G. No splices or taps permitted in feeder or branch circuit terminating in a single outlet.

H. Branch circuit splices and taps in junction and outlet boxes: Twist-on connectors.

I. Conductor and cable copper shall not be reduced at the terminal for making connections.

J. Slack shall be left at equipment, pullboxes, or outlet boxes to allow for a neat termination.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electric and power system grounding

B. Communication system grounding

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Provide grounds in accordance with National Electrical Code and additional requirements as required herein.

B. NEC references below are based on the 2017 edition and State of Washington, Electrical Safety Standards, Administration and Installation – WAC 296-46B.

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – Common Work Results for Electrical. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Grounding conductors		X						

PART 2 - PRODUCTS

2.01 GROUNDING CONDUCTORS

A. Size: Grounding Electrode Conductor: Table 250-66. Equipment grounding conductor: Table 250-122.

B. Material: Copper.

C. Protection: Conductors not in raceway or concealed shall be insulated. Provide conduit where shown or required for physical protection.

D. Bonding Jumpers: Same requirements.

PART 3 - EXECUTION

3.01 POWER SYSTEM GROUNDING

A. All main building grounding shall be non-reversible connections using exothermic welding or compression.

B. Circuit Grounding: Install grounding bushings, studs, and jumpers at distribution centers, pullboxes, motor control centers, panelboards, and junction boxes.

C. Ground Connections: Clean surfaces thoroughly before applying ground lugs or clamps. If surface is coated, the coating must be removed down to the bare metal. After the coating has been removed, apply a noncorrosive approved compound to cleaned surface and install lugs or clamps. Where galvanizing is removed from metal, it shall be painted or touched up.

D. Conduit Systems:
1. Ground all metallic conduit systems.
2. Non-metallic conduit systems shall contain a grounding conductor.
3. Conduit provided for mechanical protection containing only a grounding conductor, bond to that conductor at the entrance and exit from the conduit.

E. Feeders and Branch Circuits: Install green grounding conductors with feeders and branch circuits as follows:
1. Feeders
2. Circuits serving preparation and kitchen equipment
3. Receptacle outlets
4. Directly connected laboratory equipment
5. Motors and motor controllers
6. Fixed equipment and appliances
7. Items of equipment where the final connection is made with flexible metal conduit shall have a grounding wire
8. Additional locations and systems as shown

F. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the grounding wires to each pullbox, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass (except for special grounding systems for intensive care units and other critical units shown.
2. Provide lugs in each box and enclosure for ground wire termination.
3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs for terminating the ground wires.

G. Receptacles - Refer to Section 26 27 26 – WIRING DEVICES.

H. Ground lighting fixtures to the green grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

I. Cross off with indelible ink as bolts are torqued to specifications. Maintain Torque Log Sheets as proof of proper installation practice of Torqueing of grounding bolts. (ASI-04)

3.02 COMMUNICATION SYSTEM GROUNDING CONDUCTOR

A. Use minimum 6 AWG copper conductor.

B. Leave 10 feet slack conductor at terminal board.

END OF SECTION

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Raceway Supports

1.02 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 0500 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Raceway supports		X						
Anchor methods		X						

PART 2 - PRODUCTS

2.01 RACEWAY SUPPORTS

A. Single Runs: Steel rod hangers, galvanized single hole conduit straps, or ring bolt type hangers with specialty spring clips. Plumbers perforated tape or "J-nails" not acceptable.

B. Multiple Runs: Conduit rack with 25 percent spare capacity. Maximum width per manufacturer's recommendations.

C. Vertical Runs: Channel support with conduit fittings.

D. All hardware such as inserts, straps, bolts, nuts, screws and washers shall be galvanized or cadmium-plated steel.

2.02 ANCHOR METHODS

A. Hollow Masonry and Framed Walls: Toggle bolts or spider type expansion anchors.

B. Solid Masonry: Lead expansion anchors or preset inserts.

C. Metal Surfaces: Machine screws, bolts, or welded studs.

D. Wood Surfaces: Wood screws.

E. Concrete Surfaces: Self-drilling anchors.

F. All anchors shall be removable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads required.

B. Exact location and spacing between supports per manufacturer's recommendations and NEC requirements as minimum.

C. Conduit shall be installed in such a manner as to prevent the collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps wherever possible.

D. Conduit risers exposed in wire shafts shall be supported at each floor level by means of approved U-clamp hangers.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Conduit, Tubing, and Fittings

B. Flexible Conduit

C. Electrical boxes and fittings as required for a complete installation

1.02 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)
1. NFPA 70 National Electrical Code--Chapter 3

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – Common Work Results for Electrical. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Outlet boxes		X						
Weatherproof outlet boxes		X						
Weatherproof junction and pull boxes		X						
Pull boxes		X						

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

A. Conduit and Tubing: Galvanized steel rigid threaded conduit, electrical metallic tubing, intermediate metallic conduit, Schedule 40 PVC.

B. Flexible Conduit: Steel armor, flexible plastic jacketed type with liquidtight connectors (liquidtight flexible metallic conduit).

C. Fittings:
1. General: Approved for purpose. Water, concrete tight where required.
2. Galvanized Rigid Steel Conduit (GRC): Threaded - no pressure type. Bushings with factory insulated throat.
3. Electrical Metallic Tubing (EMT): Connectors and couplings to be case steel. Preinsulated connectors and couplings shall be compression, setscrew type. All connectors shall have insulated throats. Connectors larger than 1 ¼-inch shall be Thomas & Betts 200 Series insulating bushing.

4. Flexible Metallic Conduit: Clamp type, galvanized malleable iron with insulated throat.
5. Liquidtight Flexible Metallic Conduit: Continuous copper ground in core; approved watertight.

D. Expansion Joints: Offset or sliding type with bending straps and clamps. Approved for purpose.

2.02 TYPE

A. Utilize GRC or IMC in concrete with concrete-tight connectors or exterior with watertight connectors.

B. Utilize electrical metallic tubing concealed in interior spaces or exposed in unfinished, interior where not subject to physical damage.

C. Utilize surface metal raceways for exposed runs in finished areas. Paint to match wall finish.

D. Make connections to motors and equipment with flexible metallic conduit or liquidtight flexible metallic conduit. Use liquidtight type in damp locations. Minimum size 1/2-inch for motor connections. Use 3/8-inch only for fixture and control wiring. Provide sufficient length of flexible conduit to avoid transmission of vibration. Sizes not noted on the Drawings shall be as required by the NEC.

E. Utilize schedule 40 PVC with rigid steel elbows and risers under slab or underground.

2.03 OUTLET BOXES

A. Minimum Box: 4-inch box, 2-1/8-inches deep. Provide raised covers on bracket surface mounted outlets, plaster rings on flush outlets.

B. Flush Switch and Receptacle Outlets for One or Two Devices: 4-inch square box, 2-1/8-inches or deeper, with single or two-gang plaster ring.

C. Three or More Devices at One Location: Use one-piece gang boxes with device cover, install one device per gang.

D. Provide galvanized steel interior outlet wiring boxes, of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

E. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations. Choice of accessories is Installer's option.

F. Outlet Box Plate Covers:
1. Flush Mounting: Beveled, pressure formed, type 302 stainless steel, match device installed.
2. Surface Mounting: Beveled, steel, pressure formed.

2.04 WEATHERPROOF OUTLET BOXES

A. Provide corrosion-resistant cast metal weatherproof outlet wiring boxes, of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and corrosion proof fasteners.

B. Weatherproof boxes to be constructed to have smooth sides, gray finish.

C. Boxes used in contact with soil shall be cast iron alloy with gasketed screw cover and water-tight hubs.

D. Weatherproof Plates: Cast metal, gasketed, for switches and receptacles provide spring loaded doors.

2.05 WEATHERPROOF JUNCTION AND PULL BOXES

A. Provide galvanized sheet steel junction and pull boxes, with screw-on covers; of the type, shape and size, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

2.06 PULLBOXES

A. Pullboxes and Junction Boxes: Sheet metal (indoors) or cast metal (exterior or damp locations) construction, conforming to National Electrical Code, with screw-on cover.

B. Flush Mounted Pullboxes: Provide overlapping covers with flush-head retaining screws, finished in light gray enamel.

C. Box volumes shall meet NEC for size and number of entering conduits.

PART 3 - EXECUTION

3.01 RACEWAY INSTALLATION

A. Install conduit concealed in all areas excluding mechanical and electrical rooms, connections to motors, connections to surface cabinets, underfloor spaces, and above suspended ceilings.

B. Owner review and approval is required for any conduit buried in slab on grade applications.

C. Owner’s FS Electrician(s) is to walk through the project to view pathways prior to encasement or enclosure.

D. MC cable allowed for final connection to one light fixture from a single junction box. Daisy changing fixtures or junction boxes with MC cable is not allowed.

E. For exposed runs, attach surface mounted conduit with one- or two-hole straps.

F. Size conduit for Type THW conductors. Minimum conduit size for home runs and backbone conduit system is 3/4 inch. Individual branch circuits from backbone junction boxes to device or fixture locations may be run in 1/2-inch conduit.

G. Coordinate installation of conduit in masonry work.

H. Conduits shall be filled no greater than 40 percent.

I. Install conduit free from dents and bruises. Plug ends to prevent entry of dirt or moisture.

J. Clean out conduit before installation of conductor.

K. Alter conduit routing to avoid structural obstructions, minimizing crossovers. Conduit routing to remain clear of areas designated for other disciplines such as mechanical access ways and valve access, close coordination with other trades is required. Bends and offsets shall be avoided where possible, but when necessary shall be made with an

approved hickey or conduit bending machine. The use of a pipe tee or a vise for bending conduit will not be permitted.

L. Provide UL approved expansion fittings complete with grounding jumpers where conduits cross building expansion joints and for long runs where conduit expansion may be excessive. Provide bends or offsets in conduit adjacent to building expansion joints where conduit is installed above suspended ceilings.

M. Route all exposed conduits parallel or perpendicular to building lines.

N. Allow minimum of 6 inches clearance at flues, steam pipes, and heat sources.

O. Vertical Runs: Straight and plumb

P. Raceways Running in Groups: Run at same relative elevation, properly spaced and supported.

Q. Individual data/voice station outlets will be served by at least 3/4-inch conduit run from nearby cable tray to station location that will be equipped with 4-inch-deep square box with single mud ring.

R. In equipment rooms, run conduit on wall surfaces in a neat fashion as high on the wall as possible.

S. Dissimilar Metals: Avoid contact with pipe runs of other systems.

T. Lengths and Bends: Maximum number of bends in any run shall be the equivalent of four quarter bends (360 degrees total). Maximum length of any run shall be 300 feet, less 50 feet for each equivalent quarter bend. Junction and pull boxes shall be provided to maintain these limits.

U. Provide waterproof seal for all exterior wall and underground raceway penetrations.

V. All empty raceways shall be provided with pull string or #12 conductor.

W. Conduit routing shall remain clear of areas designated for other disciplines, such as mechanical access ways and valve access areas.

3.02 BOX INSTALLATION

A. All outlet box locations are required to be reviewed by the Owner prior to conduits being installed. Installation of conduits shall not proceed until locations have been reviewed and approved by the Owner.

B. Locate outlet boxes flush in areas other than mechanical rooms, electrical rooms, and above suspended ceilings.

C. Minor changes in the location of outlets from those shown on the plans shall be made without extra charge if so direct by the Project Manager before installation.

D. For boxes mounted in exterior walls make sure that there is insulation behind outlet boxes to prevent condensation in boxes.

E. Coordinate location and mounting heights with built-in units. Adjust outlet mounting height to agree with required location for equipment served.

F. Locate pullboxes and junction boxes above suspended ceilings or in electrical rooms, utility rooms, or storage areas.

G. Support: Secure boxes independent of entering conduits, by attaching directly to structure with bar hanger, blocking or flat side bracket.

H. Identify each junction and pullbox with system description including branch circuit numbers of enclosed circuits.

I. Conduit shall be securely fastened to all sheet metal outlet, junction, and pullboxes with galvanized locknuts, and bushing.

J. Do not install boxes back-to-back in walls. Boxes on opposite sides of wall shall be separated by a minimum of 6 inches, except where installed in acoustic-rated walls, where a minimum 24-inch separation is required.

K. Boxes are to be cleaned inside and out upon completion and prior to acceptance of work.

END OF SECTION

SECTION 26 05 48

SEISMIC CONTROL FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Design and installation of seismic restraint of new electrical equipment, conduit, and cable tray installed hereunder. Exceptions include equipment whose structural attachment has been designed by the project structural engineer including:
   1. Not included in this submittal.

B. Seismic restraint of existing equipment, conduit, and cable tray where restraint is required to allow code required restraint of new equipment, conduit, or cable tray.

1.02 DEFINITIONS

A. Custom Engineered Assembly: Anchorage and seismic restraint assembly comprised of standard or proprietary components, designed and applied to system by the seismic restraint system Engineer.

B. Pre-Engineered Assembly: Previously designed anchorage and seismic restraint assembly selected and applied to system by the seismic restraint system Engineer.

C. Equipment:
   1. Includes (but not limited to) transformers, panelboards, conduit, etc. Equipment referred to by type is typical. Equipment not specifically listed here is still subject to the requirements listed herein.
   2. Weight: Installed operating weight of equipment as reported by equipment manufacturer.
   3. Floor-Mounted: Equipment located on and attached to floor.

1.03 DESIGN REQUIREMENTS

A. Restraint system, assemblies, and components shall be designed and installed to resist lateral loads in accordance with the current adopted International Building Code (IBC).

B. Seismic Design Criteria: Per IBC for project site.

C. Seismic restraint design calculations shall consider localized effects on structural elements induced by the connection loads.

1.04 SYSTEM ENGINEERING AND QUALITY ASSURANCE

A. Seismic restraint system shall be engineered to comply with criteria stated and referenced herein.

B. System engineering shall be performed by a Structural Engineer currently licensed to practice in the State of Oregon.

C. System engineering shall include design and application of Custom Engineered and/or Pre-Engineered Assemblies, as applicable to this project. Design shall include detailed load calculations and specific restraint system requirement at each restraint location.

D. Approved System Engineering Services: Mason Industries, Amber-Booth, Kinetics, Vibro-Acoustics, or an independent structural engineer.

1.05 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – Common Work Results for Electrical. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All products in this Section								X

B. Special Requirements:
1. Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic forces.
   a. Seismic Restraint Location Plan: Full or half size copies of conduit and cable tray plans from the Contract Documents or Coordination Drawings, showing locations and specific seismic restraint assembly parameters for each restraint to be installed. Drawings shall consist of mechanically reproduced copies of the Contract Documents, or custom drafted specifically for the Work of this Project. Each drawing shall be printed on a single sheet. Drawings pieced together from multiple copies are not acceptable.
   b. Seismic Restraint Assembly Installation Details: Pre-Engineered or Custom Engineered assembly details showing required components, dimensions, and method of connection to supporting structure.
   c. Calculations for System Application: Calculations shall indicate maximum forces anticipated at each restraint assembly, method of determining forces, and selection of restraint assemblies.
      1) For Pre-Engineered Assemblies, include documentation of assumed design conditions and maximum load capacity of assembly, certified by a Registered Professional Engineer.
      2) For Custom Engineered Assemblies, submit calculations identifying maximum load capacity of assembly, maximum forces on each component, sizing/selection of each component and maximum forces at anchorage points.
2. The entire submittal package comprised of drawings, details, and calculation shall be stamped and signed by the seismic restraint system Engineer.
3. At completion of seismic restraint system installation, submit three (3) copies of report from seismic restraint system Engineer, or the Engineer's representative, certifying that seismic restraints are installed in conformance with approved shop drawings and no additional restraints are necessary based on field conditions. Include written authorization, from seismic restraint system Engineer or the designated representative

PART 2 - PRODUCTS

2.01 PRE-ENGINEERED ASSEMBLIES

A. Acceptable Manufacturers: Mason Industries, Amber-Booth, Kinetics, Tolco, B-Line, Vibro-Acoustics, or approved.

B. Anchorage and seismic restraint assembly comprised of standard or proprietary components, capable of application to restraint system and supporting structure.

C. Assemblies may be selected from SMACNA Seismic Restraint Manual or as engineered by an approved proprietary manufacturer.

D. Component importance factor for seismic restraints of life-safety equipment shall be 1.5.

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate the design of seismic restraint systems with contract documents indicating a specific seismic design approach and load capabilities of the existing building structure.

B. Coordinate the design of seismic restraint systems with the equipment and conduit support structure provided hereunder.

C. Where information presented in the contract documents is not adequate to allow design of seismic restraint, provide a request for information including a listing of specific information required.

D. Notify the Engineer when the existing building support structure or new equipment and conduit support structure is not adequate to provide seismic restraint.

E. Coordinate the seismic restraint design with new equipment to ensure manufacturer's recommended maintenance clearances are maintained.

3.02 INSTALLATION

A. Install seismic restraint system in strict accordance with the manufacturer's written instructions and certified submittal data.

B. Maintain all existing walkways and service routes clear of seismic restraint cables and other restraint equipment.

C. Attach restraints and anchors to a common structural element plane and within a common structural system.

D. For non-isolated suspended equipment and conduit, install solid braces or taut flexible cable restraints.

E. E.Provide supplementary support steel for equipment, conduit, and cable tray required for the Work of this Section.

F. Equipment Seismic Restraint
1. Coordinate size of new structural support pad and/or concrete piers to ensure adequate space for required bases, isolators, restraints, and attachment thereto.

G. Conduit and Cable Tray Seismic Restraint
1. Provide minimum of two transverse supports and one longitudinal support on each conduit or cable tray run. Transverse bracing shall be installed at each turn and at each end of a run with a minimum of one brace at each end. Where a conduit or cable tray is shorter than the minimum interval between braces, provide braces at each end.
2. Where restraints are attached to clevis style conduit hangers, the cross bolt must be reinforced.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Nameplates

B. Wire and cable markers

C. Pull box and junction box identification

D. Device plate identification

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Identification shall conform to the latest edition of the National Electrical Code (NEC), Articles 110-21 and as a minimum requirement.

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – Common Work Results for Electrical. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Engraved laminated plastic		X						
Adhesive film labels		X						

PART 2 - PRODUCTS

2.01 MATERIALS

A. Nameplates:
1. Three-layer, white front and back with black core laminated plastic.
2. Engraved through outer layer to show white characters on black background.
3. Beveled edges.
4. NEC Article 700 Systems (Lighting Inverter)
   a. Same nameplate requirements listed above, but with orange nameplate white characters for emergency systems distribution equipment.

B. Wire and Cable Markers:
1. Heat shrink thermo-labels.
2. Brady or Panduit.

C. Labels:
1. Adhesive Film Labels: Machine printed, in black on clear background, by thermal transfer or equivalent process.
2. Emergency receptacles/wall switches: Black on red background.

D. Panelboard Directory Card: Fiberboard neatly typed for newly installed panels. Circuit changes to existing panels shall be noted on the directory card by hand printing in ink. When more than five changes have been made on the directory card, a new card shall be typed.

PART 3 – EXECUTION

3.01 GENERAL

A. During finish construction, labeling is to be reviewed and approved by the Owner.

B. Zoned systems must be clearly defined and labeled.

C. Label at all entries into new spaces and/or through walls.

D. Covering or painting of any sign/label requires replacement.

E. Mark and label new wiring and place in tray. Include installation date.

3.02 NAMEPLATE INSTALLATION

A. Degrease and clean surfaces to receive nameplates.

B. Install nameplates parallel to equipment lines.

C. Secure nameplates to equipment fronts using screws or drive rivets.
1. Secure nameplate to inside face of recessed panelboard doors in finished locations.
2. Secure nameplate to outside face of panelboards in unfinished locations.

D. Where switches control remote lighting or power outlets, or where switches in the same outlet (two or more) serve different purposes such as lights, power, intercom, etc., or different areas such as corridor and outside, furnish either engraved nameplates or adhesive film labels with 1/4-inch black letters indicating function of each switch or outlet.

E. Use adhesive film labels for identification of individual wall switch and receptacle cover plates.

3.03 WIRE IDENTIFICATION

A. Labeling shall be non-destructible type which may not be removed during installation.

B. Provide wire markers on each conductor in panelboards, gutters, pull boxes, and at load connection.

C. Identify with branch circuit or feeder number for power and lighting circuits.

D. Tag lighting feeds with circuit number and panel ID.

E. Identify control wire number as indicated on equipment manufacturer’s shop drawings.

3.04 NAMEPLATE ENGRAVING SCHEDULE

A. Identify all electrical distribution, control equipment and disconnect switches at loads served.

B. 3/4-inch nameplates are to be fastened with sheet metal screws.

C. Disconnect switches and control units shall include circuit number and panel ID.

D. Letter Height:

1. 1/2-inch for individual switches and loads served.
2. 1/2-inch for distribution and control equipment identification.
3. 1/2-inch identifying voltage rating and source.

E. Transformers:
1. 1/2-inch; identifying equipment designation.
2. 1/2-inch; identifying primary source, and secondary load and location.

F. Automatic Transfer Switches shall have a red background with 1/2-inch white lettering.

3.05 PULL BOX AND JUNCTION BOX IDENTIFICATION

A. Provide permanent signage, interior and exterior at all utility boxes, vaults, manholes, etc.

B. Install labels on inside of junction boxes and adhesive film label on the box cover.

C. Identify each junction box with complete system description. Examples:
1. Fire alarm.
2. Telephone.
3. 480V system.
4. 208V system.

D. Methods:
1. Neat hand lettering with permanent black marker.
2. Engraved nameplates.
3. Adhesive film labels.

E. Fire alarm junction boxes:
1. Paint fire alarm junction boxes and covers red and label “FIRE ALARM” prior to installation.

F. Locations:
1. On outside of box cover where concealed.
2. In exposed box locations, locate on inside of box cover.
3. Identify main pull boxes by number and indicate numbers on record drawings.

3.06 DEVICE PLATE IDENTIFICATION

A. 1/4-inch letter height.

B. Black letter color.

C. Location:
1. Bottom center of device plate for single gang and multiple gang outlets.
   a. Provide branch circuit identification (example: “B-16” indicating panel “B” circuit #16).

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provide panelboards incorporating switching and protective devices of the number, rating and type specified herein and shown in Panel Schedules.

1.02 RELATED SECTIONS

A. Section 26 05 53 – Identification for Electrical Systems

1.03 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
1. 67 Panelboards (ANSI/UL 67)
2. C37.20 Switchgear Assemblies Including Metal-Enclosed Bus (ANSI/IEE C37.20)

B. Institute of Electrical and Electronics Engineers (IEEE)
1. Std. 141-76 Electric Power Distribution for Industrial Plants
2. Std. 241-74 Electric Systems for Commercial Buildings

C. National Fire Protection Agency (NFPA)
1. NFPA 70 National Electrical Code

D. Underwriters' Laboratory (UL)
1. U.L. 67 Panelboards
2. U.L. 869 Service Disconnects

1.04 SUBMITTALS

A. Submit shop drawings for equipment and component devices under provisions of Section 26 05 00.

1.05 QUALITY ASSURANCE

A. Coordination: Panelboard breakers shall be coordinated with feeder breakers in switchboard.

B. Acceptable Manufacturers: Square D and Siemens.

1.06 SPARE PARTS

A. Keys: Furnish one each per panelboard to Owner
1. Panelboards shall be keyed to Cat 70.

PART 2 - PRODUCTS

2.01 MAIN AND DISTRIBUTION PANELBOARDS

A. Enclosure:
1. Indoor: NEMA Type 1 unless otherwise noted.
2. Provide cabinet front with concealed screw cover and hinged door with flush lock.
3. Finish in manufacturer’s standard gray enamel.

4. Cabinet width and depth as shown on Drawings. If specified size is in conflict with size as supplied by equipment manufacturer, notify Engineer and Owner's Authorized Representative during bidding phase of project.
5. Door-in-door construction.
    a. Hinged Outer trim:
        i. Flush mount: Screw cover with 3/4" cabinet overlap.
        ii. Surface mount: Match cabinet dimensions.
    b. Circuit breaker door:
        i. Concealed hinge.
        ii. Flush locking latch, all keyed the same.
    c. Dead front door:
        i. Hinged with outer trim and secured with screws at latch side.

B. Bussing:
1. Silver plated, copper bus.
2. Ratings as scheduled.
3. Provide full length coper ground bus in all panelboards.
4. Full size neutral bus.
5. Minimum Integrated Short Circuit Rating:
    a. Unless noted otherwise on Drawings 25,000 amperes rms symmetrical for 240-volt panelboards; 25,000 amperes rms symmetrical for 480-volt panelboards.
6. Bussing shall be sized in accordance with UL 891 limited to a heat rise of 65°C.

C. Thermal Magnetic Molded Case Circuit Breakers:
1. Quick-make, quick-break, and trip indicating.
2. All two and three pole breakers shall have internal common trips.
3. Circuit breaker with frame sizes greater than 100 amperes shall have variable magnetic trip elements which are set by a single adjustment.
4. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

D. Solid-State, Digital RMS Sensing, Molded Case Circuit Breakers:
1. Quick-make, quick-break, with common tripping off all poles.
2. Digital solid state, ambient insensitivity tripping.
3. All frames from 30A to 1200A shall use field-installed, UL listed rating plugs to establish (or change the ampere rating).
4. All breaker frame sizes shall have a single, customer-adjustable, instantaneous pickup knob to set the instantaneous response for all poles.
5. Provide electronic trip units that allow for monitoring of both energy and power through breaker. Units shall allow for metering functions and communication capability.
6. Internal accessories shall be UL listed for field installation and shall not require circuit breaker cover removal. Provide the following accessories if indicated on panel schedules:
    a. Shunt trip.
    b. Undervoltage releases.
    c. Auxiliary switches.
    d. Bell alarms.
7. Where indicated on the Drawings provide instantaneous-only breakers for motor circuit protection.
8. Where indicated on the Drawings, provide current limiting.

2.02 LIGHTING AND APPLIANCE PANELBOARDS

A. Enclosure:
1. Indoor: Type 1, unless otherwise noted.
2. Outdoor: Type 3R.
3. Cabinet size: 6 inches deep, 20 inches wide unless otherwise noted.
4. Provide cabinet with concealed trim clamps, concealed hinge and flush lock all keyed alike.
5. Finish in manufacturer's standard gray enamel.

6. Door-in-door construction.
    a. Hinged Outer trim:
        i. Flush mount: Screw cover with 3/4” cabinet overlap.
        ii. Surface mount: Match cabinet dimensions.
    b. Circuit breaker door:
        i. Concealed hinge.
        ii. Flush locking latch, all keyed the same.
    c. Dead front door:
        i. Hinged with outer trim and secured with screws at latch side.

B. Bussing:
1. Copper bus, rating as scheduled on Drawings.
2. Provide copper ground bus in all panelboards.
3. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 240-volt panelboards; 14,000 amperes rms symmetrical for 480-volt panelboards, or as shown on Drawings.
4. Bussing shall be sized in accordance with UL 891 limited to a heat rise of 65°C.

C. Molded Case Circuit Breakers:
1. Bolt-on type thermal magnetic molded case with quick-make, quick-break action.
2. Common trip handle (no external brackets) for all poles with “ON”, “OFF”, and “TRIPPED” positions.
3. UL listed as Type SWD for lighting circuits.
4. UL Class A ground fault interrupter circuit breakers where scheduled.
5. Fully rated.

2.03 SERVICE ENTRANCE EQUIPMENT

A. Provide factory installed service entrance-type UL label for service entrance panelboards.

B. Include connector for bonding and grounding neutral conductor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb, in conformance with NEMA PB 1.1.

B. Height: 6ft. 6 inches to center of the grip of the operating handle of the highest switch or breaker.

C. Provide mounting brackets, busbar drillings, and filler pieces for unused spaces.

D. Prepare and affix typed directory to inside cover of panelboard indicating loads controlled by each circuit as required elsewhere in these Specifications. Revise directory to reflect circuiting changes required to balance phase loads.

E. Provide panelboards flush in areas other than mechanical rooms, electrical rooms, and above removable ceilings.

F. Conduit shall be securely fastened to all panelboards and sheet metal outlet, junction, and pull boxes with galvanized locknuts, and one bushing installed in accordance with standard practice. The full number of threads shall project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be made up sufficiently tight to draw each into firm electrical contact with the box.

G. Keys: Collect all panel keys. Combine all keys on one key ring and submit at time of Substantial Completion.

H. The phase conductors feeding each panelboard shall have a clockwise rotation.

3.02 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits. Provide written verification to Engineer and Owner's Authorized Representative.

B. Visual and Mechanical Inspection:
   1. Inspect for physical damage, proper alignment, anchorage, and grounding.
   2. Check proper installation and tightness of connections for circuit breakers.

C. Clockwise phase rotation shall be tested and documented. Provide documentation of correct phasing for each panelboard.

END OF SECTION

SECTION 26 27 16

ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical Cabinets

B. Communications Cabinets

C. Lighting Cabinets

1.02 REFERENCE STANDARDS

A. Underwriter's Laboratory (UL)
1. UL50 Cabinets and Boxes

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Cabinet		X						
Backboard	X							
Terminal strips		X						
Identification		X						
Wiring diagrams					X			

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cabinets: Metal construction, conforming to National Electrical Code, finish painted, equipped with locking door, concealed flush hinges, flush lock, and catch assembly. All locks keyed alike and alike with panelboards.

B. Backboard: 3/4-inch fir plywood, one piece per cabinet. Provide matte black finish.

C. Terminal strips:
1. Below 50 volts: Screw terminal type
2. Above 50 volts: 250-volt screw terminal type with barriers between each set of terminals and individual terminal points for each conductor.

D. Identification: Identify terminal strips with permanent numbers. Identify conductors terminating on terminal strips with permanent labels attached to the conductor at the terminal strip.

E. Wiring Diagrams: Provide wiring diagram on inside of each cabinet door showing units and conductors connected to cabinet.

F. Provide barriers in cabinets as required to separate conductors of different systems.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Terminate wiring on terminal blocks or strips.

B. Vacuum clean cabinet on completion of installation.

C. Mount cabinets flush or surface as shown on Drawings with top 6'-0" above finished floor.

D. Stubs: Provide minimum 3-3/4-inch C stubs into accessible ceiling space.

E. Conduit shall be securely fastened to all cabinets with galvanized locknuts and bushing. Provide raintight hubs as required for enclosure type.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Wall Switches

B. Receptacles

C. Ground Fault Receptacles

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
1. 467 Grounding and Bonding Equipment (ANSI/UL467)
2. 498 Attachment Plugs and Receptacles (ANSI/UL498)
3. C73 Series Dimensions of Attachment Plugs and Receptacles

B. Federal Specification (FS)
1. W-C-596D and E Specification for Electrical Power Connector, Plug, Receptacle and Cable Outlet.

C. National Electrical Manufacturer's Association (NEMA)
1. WD 1-79 General Purpose Wiring Devices

D. National Fire Protection Association (NFPA)
1. NFPA 70 National Electrical Code

E. Underwriters' Laboratory (UL)
1. UL-20 Standard for Snap Switches

1.03 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Switches			X					
Duplex receptacles			X					
Ground fault receptacles			X					
Wall plates			X					
Color			X					

1.04 QUALITY ASSURANCE

A. Receptacles shall be Industry Class 5362.

B. Acceptable Manufacturers: Hubbell, Leviton, or approved.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Switches: 120/277 Volt. AC Quiet, slow-make, slow break design, toggle handle, with totally enclosed case, rated 20 ampere, heavy duty, industrial grade. Provide matching two-pole, three-way and four-way switches.

B. Switch and Pilot Light: Toggle action type with red handle, integral long-life neon pilot light, rated at 15 ampere, 120 volts.

C. Duplex Receptacles: Full gang size, polarized, duplex, parallel blade, U-grounding slot, heavy duty, industrial grade, rated at 20 amperes, 125 volts (unless otherwise noted), designed for split feed service.

D. Ground Fault Receptacles: Heavy duty, industrial grade duplex receptacle with integral ground fault circuit interrupter. Test and reset buttons. Matching wall plate.

E. Wall Plates: Satin stainless-steel, Type 302. Nominal .040-inch thick. Match device configuration.

F. Nameplates: Provide engraved or embossed plastic nameplates for receptacles other than standard duplex receptacles indicating voltage, phase, amperes, circuit and panel.

G. Color: Provide gray switches and receptacles in all areas.

H. Wiring devices with push-in terminals are not allowed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Furnish and install wiring devices of number, rating and type shown.

B. Devices to include appropriate outlet box, cover, wall plate and other necessary installation materials for a complete operating outlet.

C. Mount switches 48 inches (to top of box) above floor except as otherwise noted on the Drawings.

D. Coordinate switch mounting location with architectural detail.

E. Mount receptacles vertically at 18 inches (to center of box) above finished floor, with grounding pole at bottom. Verify exact height and orientation of outlets with Architectural Details prior to rough-in.

F. Coordinate receptacle height with benches and counters.

G. When mounting receptacle above bench or counter, mount vertically at height indicated (to center of box) with ground pole down, unless otherwise noted. Verify exact height and orientation of outlets with Architectural Details prior to rough-in.

H. Back wiring wells may be used for receptacles.

I. Where outlets are adjacent to each other at same mounting heights, install under common device plate, except where outlet are of different voltages, such as telephone and duplex receptacles, unless otherwise noted.

J. Grounding: Install a separate green or bare wire between the receptacle strap grounding (green) screw and a screw into the outlet box. Self-grounding strap not approved as grounding means.

END OF SECTION

SECTION 26 28 16

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Circuit Breakers

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
1. C37.16 Preferred Ratings, Related Requirements, and Application Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors.
2. C37.17 Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers.

B. Federal Specifications (FS)
1. W-C-375B/GEN Circuit Breakers, Molded Case; Branch Circuit and Service, Federal Supply Classification (FSC) 5925.
2. W-C-375 (1 through 20) Circuit Breakers, Molded Case, Branch Circuit and Service (FSC) 5925.

C. Institute of Electrical and Electronic Engineers, Inc. (IEEE)
1. 20-73 Low Voltage AC Power Circuit Breakers Used in Enclosures (ANSI C37.13-73).

1.03 APPLICABLE REGULATIONS

A. Underwriters' Laboratories (UL)
1. UL 489-72 Molded Case Circuit Breakers and Circuit Breaker Enclosures
2. UL 869 Service Disconnects

B. National Fire Protection Association (NFPA)
1. NFPA 70 National Electrical Code

1.04 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – Common Work Results for Electrical. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Molded case circuit breakers			X	X				

PART 2 - PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKERS

A. Circuit Breakers:
1. Connection to Bus: Bolt-on
2. Thermal-magnetic, molded case, with inverse time current overload and instantaneous magnetic tripping unless otherwise shown.
3. Quick-make, quick-break, with tripped indication clearly shown by breaker handle taking a position between ON and OFF.
4. Multi-pole breakers shall have a common internal trip. No handle ties between single pole breakers.
5. Contacts: T-rated, for heavy duty switching applications
6. Breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the breaker trip rating to prevent repeated arcing shorts resulting from frayed appliance cords.
7. Additions to existing panelboards and switchboards shall match or be compatible with existing.
8. Provide handle ties per NEC for breakers serving circuits with shared neutral conductors.
9. Where used as service disconnects, breakers shall be listed for use as service entrance equipment.

PART 3 - EXECUTION

3.01 CIRCUIT BREAKER INSTALLATION

A. Label each breaker located in switchboard or separate enclosure to indicate load served.

B. Adjust settings on breakers to operate properly under actual field conditions and to provide selective system coordination.

C. Update directory in panelboards which have new breakers installed.

END OF SECTION

SECTION 26 29 13

MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provide and install motor disconnects as shown and as required by Codes.

B. Provide and install circuit disconnects as shown and as required by Codes.

C. Disconnects to include mounting stands, brackets, plates, supports, and required hardware and accessories for complete installation.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Conform to National Electrical Code and to applicable inspection authority.

B. Provide circuit and motor disconnects in the proper enclosure as required by NEC for the location installed unless more stringent requirements otherwise noted on the Drawings or herein.

1.03 REFERENCE STANDARDS

A. Underwriters' Laboratory (UL)
1. Annual Product Directories
2. UL-98 Enclosed Switches

B. National Electrical Manufacturer's Association (NEMA)
1. NEMA KS-1 Enclosed Switches

1.04 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 26 05 00 – General Electrical Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List
2. Catalog Data
3. Product Data
4. Performance Data
5. Wiring Diagrams
6. Shop Drawings
7. Installation Instructions
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Components			X	X				
Single phase manual motor controller			X	X				

PART 2 - PRODUCTS

2.01 COMPONENTS

A. Motor and circuit disconnects shall have an Underwriters' Laboratory label.

B. Three-Phase Disconnect Switches: Three-pole heavy duty quick make, quick break 600 volt. Number of poles and ampacity as noted or required by Code. Fusible where noted

with fuse clips suitable for dual element fuses unless current limiting fuses are noted. Short circuit rating sufficient to withstand the available fault current or let-through current before the fuse melts without damage or changes in rating.

C. Compression or set-screw lugs approved for use with copper wire.

D. ON/OFF Positions: Clearly marked, lockable in "OFF" position.

E. Cover Interlock:
1. Prevents switch from being opened when "on."
2. Prevents closing switch when cover is open.
3. Defeater to permit authorized personnel to open door and inspect switch when "on," or operate with cover open.

F. Motor disconnects shall contain minimum 2 NO/NC control circuit disconnecting contacts interlocked with operating handle.

G. Enclosure for Dry, Indoor Locations: NEMA 1 minimum. Enclosures for outdoor locations: NEMA 3R minimum. Others as required for location installed.

2.02 MANUAL MOTOR CONTROLLER, SINGLE PHASE

A. Acceptable Manufacturer: Square D.

B. General: Manual toggle switch with handle guard and lockoff, thermal overload relay, NEMA 1 surface mounted enclosure. Square D, Class 2510 or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install motor and circuit disconnects as recommended by manufacturer and as required by Code and UL.

B. Maintain Code clearances.

C. Provide a nameplate on each motor and circuit disconnect identifying the equipment item served. Where disconnect is to be installed in existing motor control center replace existing nameplate with new nameplate identifying new equipment item served.

D. Clockwise phase rotation shall be tested and documented. Provide documentation of correct phasing for each motor.

END OF SECTION

SECTION 26 51 00

LIGHTING FIXTURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes supply and installation of luminaires, supports and accessories; and supply of plaster frames, trim rings and backboxes for plaster, tile, drywall or concrete ceilings.

1.02 REFERENCE STANDARDS

A. National Electrical Manufacturer's Association (NEMA)
1. NEMA SSL 1: Electronic Drivers for LED Devices, Arrays, or Systems.

1.03 COORDINATION

A. Confirm compatibility and interface of other materials with luminaire and ceiling system. Report discrepancies to the Engineer/Architect and defer ordering until clarified.

B. Supply plaster frames, trim rings and backboxes to other trades.

C. Coordinate with Division 22 and 23 to avoid conflicts between luminaires, supports, fittings, piping, and mechanical equipment.

1.04 JOB CONDITIONS

A. Existing Conditions:
1. Prior to ordering lighting fixtures, verify finish material in locations where lighting fixtures are mounted.
2. Prior to ordering lighting fixtures, verify conditions for mounting lighting fixtures and select proper mounting hardware.
3. Verify fire rating of new ceilings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Refer to LUMINAIRE SCHEDULE.

2.02 RECESSED LUMINAIRES

A. Recessed Incandescent Luminaires: Prewired type with junction box forming an integral part of the assembly.

B. Supply recessed luminaire complete with trim type required for ceiling system installed. Before ordering, confirm ceiling construction details and architectural finish for each area.

2.03 PENDANTS/CABLE HANGERS

A. Swivel sockets permitting normal fixture motion and self-adjustment. Adjustable to provide fixture height alignment.

B. One-piece, white finish, with matching canopies.

C. Fixtures shall be factory counter-weighted and balanced to provide level hanging. Weights shall not be visible.

D. Cable hangers shall be adjustable for a minimum of 18 inches.

2.04 LED LUMINAIRES

A. General:
1. LED light fixtures shall be in accordance with IES, NFPA, UL as shown on the Drawings and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS) compliant.
3. LED drivers shall include the following features unless otherwise indicated:
   a. Minimum Efficiency: 85% at full load.
   b. Minimum Operating Ambient Temperature: -20°C (-4°F).
   c. Input Voltage: 120-277V (±10%) at 60 Hz.
   d. Integral short circuit, open circuit, and overload protection.
   e. Power Factor: ≥ 0.95.
   f. Total Harmonic Distortion: ≤ 20%.
   g. 4-wire (0-10VDC voltage controlled) dimming driver.
      1) Capable of dimming to black from 100% to 1% light output and step to 0%. Driver shall respond similarly when raising from 0% to 100%.
   h. Driver shall be free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10).
4. LED modules shall include the following features unless otherwise indicated:
   a. Comply with IES LM-79 and LM-80 requirements.
   b. Minimum CRI 80 and color temperature 4000˚ K unless otherwise specified in LUMINAIRE SCHEDULE.
   c. Minimum Rated Life: 50,000 hours per IES L70.
   d. Light output lumens as indicated in the LUMINAIRE SCHEDULE.

B. LED Downlights:
1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers:
1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
2. Housing, LED driver, and LED module shall be products of the same manufacturer.

2.05 EXTERIOR LUMINAIRES AND ACCESSORIES

A. Enclosures: Complete with gaskets to form weatherproof assembly.

B. Provide low temperature ballasts/drivers, which will start reliably at temperatures as low as 0°F.

C. Provide site lighting fixtures with grounding lugs to ground both pole (when provided) and fixture.

D. Provide with damp or wet location labels as noted in “LUMINAIRE SCHEDULE” and as required.

2.06 ACCEPTABLE MANUFACTURERS – POLES

A. Hapco.

B. Hubbell.

C. Valmont.

D. Union Steel.

2.07 LIGHTING POLES

A. Metal Poles:
1. Round, straight.
2. Steel.
3. Anchor base.
4. Provide factory painted finish.

B. Wind Load: 100 mph velocity, with luminaires and brackets mounted.

C. Hand Hole:
1. Standard size and location as provided by manufacturer.
2. Provide matching gasketed cover plate.

D. Pole Top: Slipfitter as required.

E. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washer and hex nuts for each pole.

2.08 CORRELATED COLOR TEMPERATURE (CCT) AND COLOR RENDERING INDEX (CRI)

A. Refer to LUMINAIRE SCHEDULE.

PART 3 - EXECUTION

3.01 COORDINATION

A. Refer to Reflected Ceiling Plans for exact locations with respect to ceiling construction.

B. Consult Finish Schedule for ceiling and wall construction and finish.

C. Prior to ordering lighting fixtures, coordinate style of mounting with ceiling construction and trim details for ceiling system finally selected.

3.02 SURFACE MOUNTING

A. Attach with means that will draw fixtures snugly to finished surface without bending or tipping. Twist-on clips with studs not allowed on exposed "T" grid ceilings, except where specified. Support from channel above ceiling framing members with bolt at each corner of fixture.

3.03 PENDANTS

A. Support from structure per paragraph titled “SUPPORT”.

B. Provide steel, stranded safety cable between fixture and structure to support fixture in the event of a pendant breakage.

3.04 SUPPORT

A. Suspended ceiling:
1. Positively attach all light fixtures to the suspended ceiling system. The attachment device shall have a capacity of 150% of the lighting fixture weight acting in any direction.
2. Support grid with No. 12 minimum gage hangers attached to the grid members within 3 inches of the corner of each fixture, attached to structure above.

3. Attach two No. 12 minimum hangers from the fixture housing to the structure above. These wires may be slack.
4. Where suspended fixtures do not align with grid, provide “bridging” above grid and support from structure.
5. Support pendent-hung lighting fixtures directly from the structure above with No. 9 minimum wire or approved alternate support.

B. Support all other fixtures from structure by method rated at least five times support weight.

3.05 ACCESS

A. Recessed fixtures shall have code accessible supply. Use reach-through type fixtures in non-accessible ceilings or other suitable means. Coordinate with ceiling installer.

3.06 FIRE RATED CEILINGS

A. Where a ceiling carries a fire rating, recessed fixtures shall carry UL rating for use in protective enclosures. Coordinate installation of protective enclosures to provide sufficient air space for heat dissipation. 3-inch minimum all around.

3.07 LUMINAIRE POLES

A. Bases:
1. Size and constructed as indicated on Drawings.
2. Project anchor bolts 2 inches minimum above base.
3. Install poles plumb on bases. Provide shims and/or double nuts for adjustment as required.
4. Grout around pole base.

B. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.08 PREPARATION

A. Field Measurements:
1. See architectural reflected ceiling plans for exact location of ceiling mounted lighting fixtures.
2. See architectural elevations for exact location of wall mounted lighting fixtures.
3. Coordinate lighting fixture location in mechanical spaces with mechanical equipment. Report adverse conditions to Architect/Engineer and Owner’s Authorized Representative.
4. Lighting fixtures are generally located for symmetrical pattern and to suit structural conditions. Location changes shall be approved by Architect/Engineer and Owner’s Authorized Representative.
5. Provide reinforced concrete pole bases elevated minimum of 24 inches above finished grade when exterior lighting fixtures are located within 3’-0” of curb of vehicular traffic areas, unless otherwise noted. See detail on Drawings.
6. Do not install any work until any discrepancies discovered have been resolved.

B. Preparation of Surfaces:
1. Ensure finished surfaces of pole base tops smooth and relatively level prior to application of lighting fixture poles. Make final adjustment to plumb poles with leveling nuts.

3.09 CLEAN-UP

A. At time of acceptance, fixtures, lamps, and poles shall be clean, with visible labels removed. Touch-up any blemishes at completion of work.

B. Remove ballast leakage and dispose of cleaning materials in accordance with EPA regulations.

3.10 FIXTURES AS RACEWAYS

A. Code Reference: NEC 410-31

B. Through-Wiring: In continuous rows of fluorescent lighting, a connection to a single point in the row indicates that the branch circuit conductors are to be routed through the fixture wiring compartments and a connection made to each ballast.

3.11 EXTRA STOCK

A. Provide extra replacement LED driver(s) for each fixture type in project. Quantity: 10%. Where a fraction occurs, round up to next larger integer.

END OF SECTION

Oregon State University

Radiation Center

Cooling Design

Project # 2160-19

Corvallis, Oregon 97331

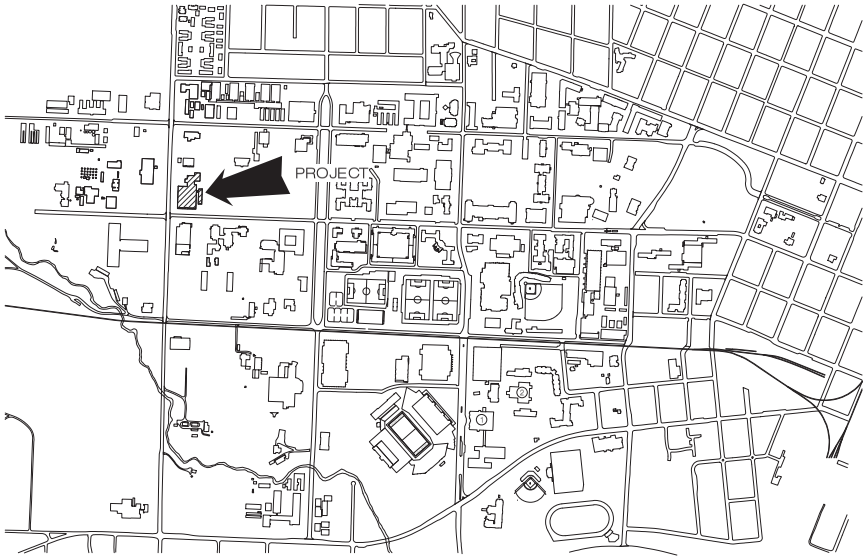
Construction Documents — November, 2019

OWNER:
OREGON STATE UNIVERSITY
Facilities Services
130 Oak Creek Building
Corvallis, Oregon 97331
Contact: David Raleigh
p. 541.230.0804
Construction Manager
david.raleigh@oregonstate.edu

MECHANICAL & ELECTRICAL:
SYSTEMS WEST ENGINEERS
725 A Street
Springfield, OR 97477
p. 541.342.7210
www.systemswestengineers.com
Contact: Paul Fooks, PE

STRUCTURAL:
STABILITY ENGINEERING
777 NE 2nd Street Suite 280
Corvallis, OR 97339
p. 541.223.5360
www.stabilityengineers.com
Contact: Shawn Stoneberg, PE

SHEET INDEX



NORTH

CAMPUS MAP

NOT TO SCALE

NORTH

SITE PLAN

NOT TO SCALE

SYSTEMS WEST ENGINEERS
725 A Street
Springfield, OR 97477
541.342.7210
systemswestengineers.com

REGISTERED PROFESSIONAL ENGINEER — DIGITALLY SIGNED OREGON — JAN. 11, 2005 — PAUL E. FOOKS

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

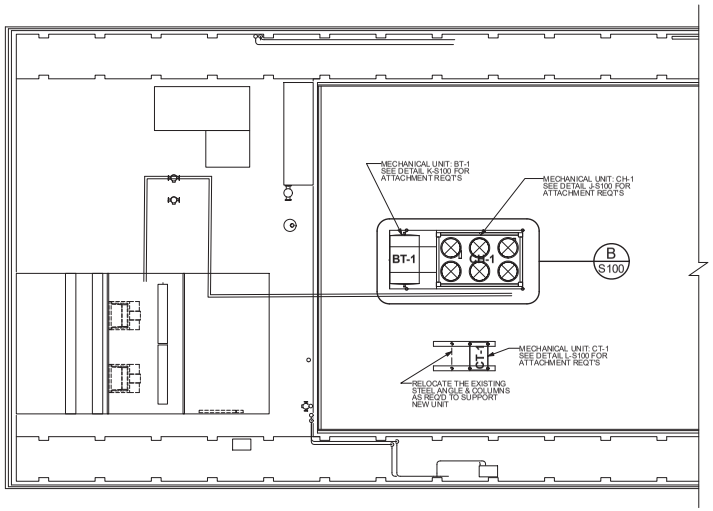
TITLE SHEET, CONTACTS, VICINITY MAP, SITE MAP & SHEET INDEX

MARK DATE DESCRIPTION

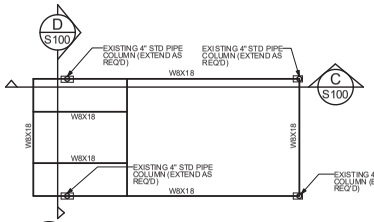
DESIGNED:	TKO
DRAWN:	JSH
CHECKED:	PEF
DATE:	11/13/2019
PROJECT:	T049.11

G001

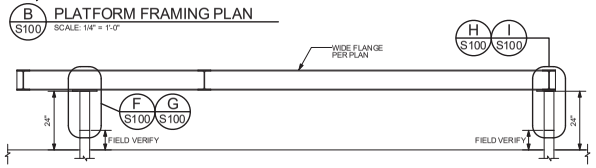
PLOTTED BY: JSH ON: 11/14/2019 5:08:19 PM



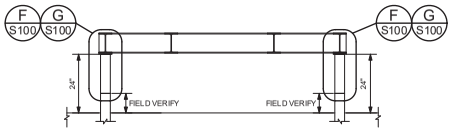
A S100 MECHANICAL UNIT BRACING PLAN - PENTHOUSE ROOF
SCALE: 1/8" = 1'-0"



B S100 PLATFORM FRAMING PLAN
SCALE: 1/4" = 1'-0"



C S100 STRUCTURAL SECTION
SCALE: 1/2" = 1'-0"



D S100 STRUCTURAL SECTION
SCALE: 1/2" = 1'-0"

GENERAL NOTES:

A. MECHANICAL UNITS & PIPEWORK ARE DESIGNED FOR THE FOLLOWING LOADS:

DEAD LOADS:
SELF WEIGHT

WIND LOADS:
BASIC WIND SPEED (V) = 120 MPH
EXPOSURE = B
IMPORTANCE FACTOR = I

SEISMIC DESIGN DATA:
SEISMIC DESIGN CATEGORY = D
SITE SOIL CLASS = D
S_s = .969
S_1 = 0.478
S_{DS} = 0.719

B. IF ANY FIELD CONDITIONS PRECLUDE COMPLIANCE WITH THESE DRAWINGS AND/OR CONDITIONS SPECIFIED, THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY AND SHALL NOT PROCEED WITH THE AFFECTED WORK. THE CONTRACTOR SHALL VERIFY ALL BUILDING DIMENSIONS, DETAILS, AND CONDITIONS PRIOR TO START OF CONSTRUCTION THAT MAY BE IMPACTED BY VARIATIONS FROM THE CONDITIONS SHOWN HEREIN.

STRUCTURAL STEEL NOTES:

A. STEEL SHALL CONFORM TO THE "SPECIFICATIONS FOR STRUCTURAL STEEL BUILDINGS, ALLOWABLE STRESS DESIGN AND PLASTIC DESIGN" LATEST EDITION, OF THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION.

B. STRUCTURAL STEEL SHALL CONFORM TO ASTM A992, EXCEPT AS MODIFIED BELOW.

C. ALL STEEL TUBE COLUMNS SHALL CONFORM TO ASTM A500, GRADE B.

D. ALL STEEL PIPE COLUMNS SHALL CONFORM TO ASTM A53, TYPE E OR S, GRADE B, OR ASTM A501.

E. ALL MISCELLANEOUS STRUCTURAL STEEL SHALL BE ASTM A36.

F. ALL HEADED STUDS SHALL CONFORM TO ASTM A-108, GRADE 1015 OR 1020.

G. ALL ANCHOR RODS SHALL CONFORM TO ASTM F1554 GRADE 36.

H. ALL WELDS SHALL CONFORM TO THE "STRUCTURAL WELDING CODE (STEEL)," AWS D1.1, LATEST EDITION.

I. BOLTS FOR STEEL TO STEEL CONNECTIONS SHALL BE ASTM A325-X BOLTS, INSTALLED TO A "SNUG TIGHT" CONDITION AND TORQUED TO 50 FT-LBS.

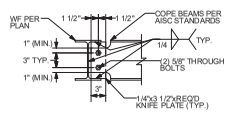
J. BOLTS FOR WOOD TO WOOD OR WOOD TO STEEL SHALL BE ASTM A307 UNLESS NOTED OTHERWISE. PROVIDE STANDARD PLATE WASHERS UNDER ALL BOLT HEADS AND NUTS IN CONTACT WITH WOOD. INSTALL "FINGER TIGHT". DO NOT OVER TIGHTEN.

K. ALL BOLTS, NUTS, AND WASHERS SHALL BE IN ACCORDANCE WITH THE LATEST SPECIFICATIONS APPROVED BY THE RESEARCH COUNCIL ON RIVETED AND BOLTED STRUCTURAL JOINTS.

L. ALL STRUCTURAL STEEL SHALL BE SHOP PRIMED WITH TWO COATS IN ACCORDANCE WITH AISC RECOMMENDATIONS.

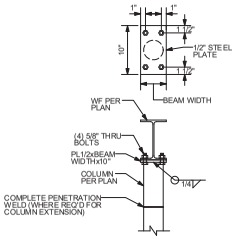
M. STRUCTURAL STEEL SHOP DRAWINGS, PREPARED BY THE STEEL SUBCONTRACTORS, SHOWING COMPLETE DIMENSIONS, DETAILS, SIZES AND GRADES OF STEEL MEMBERS AND CONNECTIONS, TYPE AND NUMBER OF WELDS AND BOLTS SHALL BE SUBMITTED FOR APPROVAL PRIOR TO FABRICATION OF THE STEEL COMPONENTS. THE STRUCTURAL STEEL SUBCONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING, VERIFICATION AND COORDINATION OF DIMENSIONS AND DETAILS WITH THE STRUCTURAL AND OTHER PORTIONS OF THE CONTRACT DRAWINGS.

M. THE STEEL FABRICATOR SHALL BE AISC CERTIFIED.

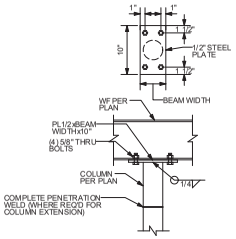


1. ALL BOLTS TO BE ASTM A325N, INSTALLED TO SNUG-TIGHT CONDITION AND TIGHTENED PER TURN-OF-THE-NUT METHOD.
2. TYPICAL BOLT SPACING = 3" ON CENTER (UNLESS OTHERWISE NOTED)
3. BOLTS TO BE INSTALLED IN STANDARD HOLES, WHERE BOTH ENDS OF A PIECE ARE TO BE BOLTED, ONE END MAY HAVE BOLTS INSTALLED USING HORIZONTAL SHORT SLOTTED HOLES IN EITHER THE BEAM WEB OR SHEAR PLATE/ANGLE (BUT NOT BOTH) PER AISC SPECIFICATIONS.
4. ANY BOLT THAT IS NOT WEATHER PROTECTED IS REQUIRED TO BE STAINLESS STEEL.

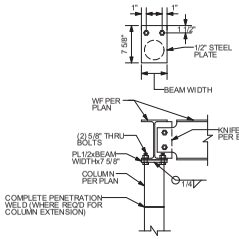
E S100 WIDE FLANGE ATTACHMENT DETAIL
SCALE: 1" = 1'-0"



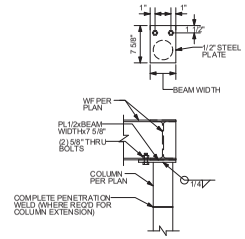
F S100 ATTACHMENT DETAIL
SCALE: 1" = 1'-0"



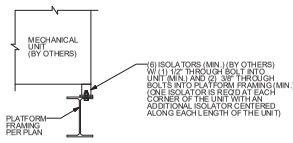
G S100 ATTACHMENT DETAIL
SCALE: 1" = 1'-0"



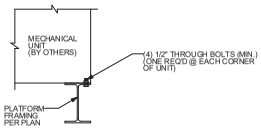
H S100 ATTACHMENT DETAIL
SCALE: 1" = 1'-0"



I S100 ATTACHMENT DETAIL
SCALE: 1" = 1'-0"



J S100 MECHANICAL UNIT ATTACHMENT
NOT TO SCALE



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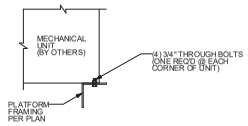
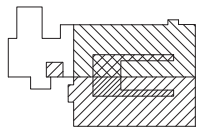
NOT TO SCALE



L S100 MECHANICAL UNIT ATTACHMENT
NOT TO SCALE



KEY PLAN
NOT TO SCALE

SYSTEMS WEST ENGINEERS
725 A Street
Springfield, OR 97477
541.342.7210
systemswestengineers.com

STABILITY ENGINEERING INC.
777 NE 2ND ST. SUITE 280
P.O. BOX 2846, CORVALLIS, OR 97339
TEL.: (541)223-5560 FAX: (541)223-5278

11/13/2019

REGISTERED PROFESSIONAL ENGINEER
OREGON
JULY 9, 2004
SHAWN STONEBERG
EXPIRES: 6/30/20

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

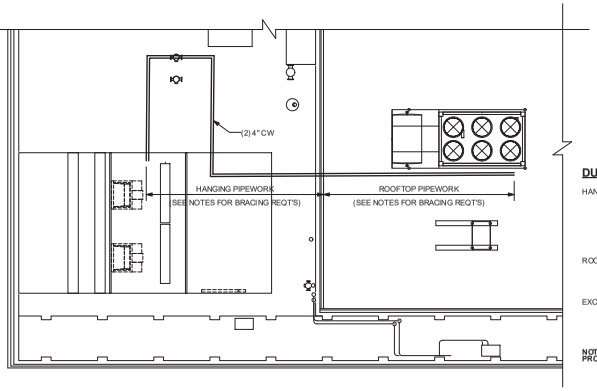
Mechanical Unit Bracing Plan

MARK	DATE	DESCRIPTION

DESIGNED: PS
DRAWN: PS
CHECKED: SS

DATE: 11/13/2019
PROJECT: 19-03.01

S100



A S101 PIPEWORK BRACING PLAN - PENTHOUSE ROOF
SCALE: 1/8" = 1'-0"

DUCTWORK WIND & SEISMIC BRACING NOTES:

HANGING PIPE WORK:

1) TRANSVERSE BRACING SHALL BE PROVIDED @ 20'-0" O.C. (MAX.) WITH A MINIMUM OF (2) TRANSVERSE BRACES INSTALLED PER PIPE RUN. SEE DETAIL B-S101 FOR BRACING REQUIREMENTS.

2) LONGITUDINAL BRACING SHALL BE PROVIDED @ 40'-0" O.C. (MAX.) WITH A MINIMUM OF (1) TRANSVERSE BRACE INSTALLED PER PIPE RUN. SEE DETAIL C-S101 FOR BRACING REQUIREMENTS.

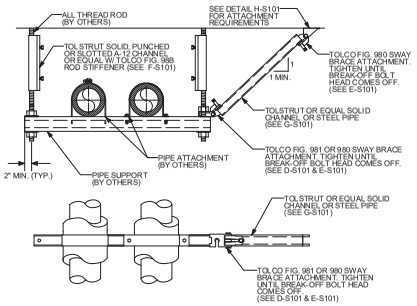
ROOFTOP PIPEWORK:

1) TRANSVERSE AND LONGITUDINAL BRACING SHALL BE PROVIDED AT EACH VERTICAL PIPE SUPPORT LOCATION. VERTICAL PIPE SUPPORTS ARE REQ'D @ 10'-0" O.C. (MAX.). SEE DETAIL I-S101 FOR BRACING REQUIREMENTS.

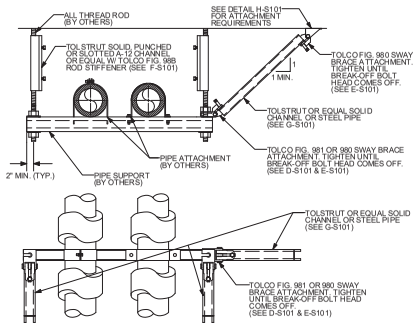
EXCEPTIONS:

1) IF DUCTWORK IS SUPPORTED BY ROD HANGERS AND EACH HANGER IN THE DUCT RUN IS 12" OR LESS IN LENGTH FROM THE DUCT SUPPORT POINT TO THE SUPPORTING STRUCTURE (WHERE ROD ATTACHES TO STRUCTURE) THEN SEISMIC BRACING IS NOT REQUIRED.

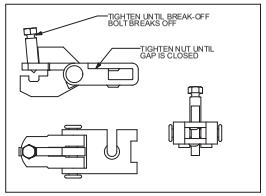
NOTE: EQUIVALENT MASON INDUSTRIES OR OTHER SEISMIC BRACING PRODUCTS MAY BE USED IN LIEU OF TOLCO PRODUCTS.

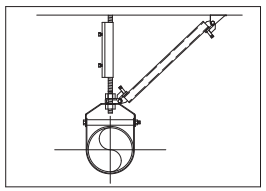


B S101 TRANSVERSE RIGID BRACE FOR TRAPEZE SUPPORTED PIPE
NOT TO SCALE

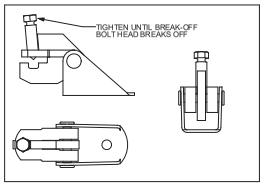


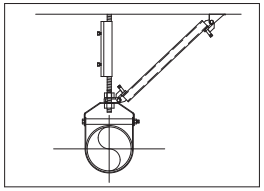
C S101 TRANSVERSE AND LONGITUDINAL COMBINATION RIGID BRACING FOR TRAPEZE SUPPORTED PIPE
NOT TO SCALE



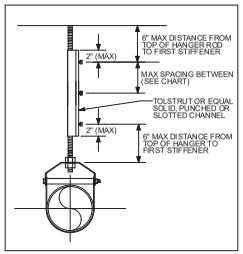


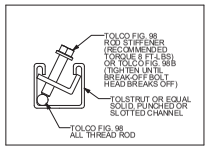
D S101 TOLCO FIG. 981 "FAST ATTACH" SWIVEL SWAY BRACE ATTACHMENT
NOT TO SCALE





E S101 TOLCO FIG. 980 SWIVEL SWAY BRACE ATTACHMENT
NOT TO SCALE



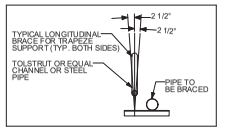


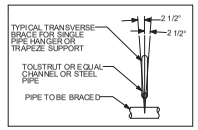
NOTES:
1. ROD STIFFENERS ARE REQUIRED ONLY ON HANGER AND TRAPEZE ASSEMBLIES THAT HAVE SEISMIC BRACING ATTACHED AT OR WITHIN 4" OF THE ROD. A MINIMUM OF TWO ROD STIFFENERS (TOLCO FIG. 98) MUST BE INSTALLED.

2. RECOMMENDED TORQUE IS 8 FT-LBS (OR FINGER TIGHT PLUS ONE FULL TURN WITH A WRENCH)

ROD SIZE	MAX ROD LENGTH WITHOUT ROD STIFFENER	MAX. SPACING BETWEEN TOLCO FIG. 98
3/8"	19"	13"
1/2"	25"	18"
5/8"	31"	23"
3/4"	37"	28"
7/8"	43"	33"
1"	50"	38"
1 1/4"	62"	43"

F S101 TOLCO FIG. 98 ROD STIFFENER
NOT TO SCALE

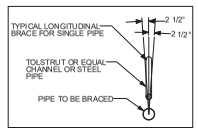




PIPE DIAMETER	MAX LENGTH	SCH.	ALLOWABLE HORIZ. SEISMIC LOAD W/ BRACE @ 45° (Lbs)
1"	7'-0"	40	1732
1 1/4"	9'-0"	40	2345
1 1/2"	10'-4"	40	2802
2"	13'-1"	40	3769
2 1/2"	16'-3"	10	2739
3"	19'-10"	10	3359
3 1/2"	22'-10"	10	3858
4"	25'-9"	10	4353

STRUT SIZE	MAX LENGTH	ALLOWABLE HORIZ. SEISMIC LOAD W/ BRACE @ 45° (Lbs)
1 5/8 x 1 5/8, 12 GA	9'-6"	2043

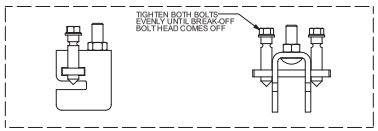
CABLE DIAMETER	MAX LENGTH	ALLOWABLE HORIZ. SEISMIC LOAD W/ BRACE @ 45° (Lbs)
1/8"	INFINITY	689
3/16"	INFINITY	1449
1/4"	INFINITY	2227

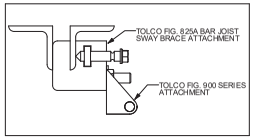


NOTES:
1. MAXIMUM ALLOWABLE LENGTHS AND CONCENTRIC LOADS WHEN L/R = 200

2. ALL LONGITUDINAL AND TRANSVERSE BRACING UTILIZING PIPE OR CHANNEL AS THE BRACING MEMBER HAS A TOLERANCE OF 2 1/2" FROM CENTER IN EITHER DIRECTION WITHOUT AFFECTING THE ALLOWABLE LOADS.

G S101 MAXIMUM ALLOWABLE LENGTHS AND CONCENTRIC LOADS FOR BRACE MEMBERS
NOT TO SCALE

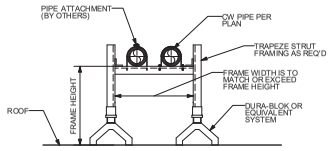




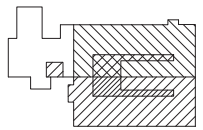
NOTES:
1) ATTACH FIG. 825A TO TOP CHORD OF BAR JOIST ONLY.

2) ALL EARTHQUAKE BRACING CONNECTIONS TO BE WITHIN 6" OF THE CORD PANEL POINT.

H S101 TOLCO FIG. 825A BAR JOIST ATTACHMENT
SCALE: 1" = 1'-0"



I S101 ROOFTOP PIPE SUPPORT DETAIL
NOT TO SCALE



NORTH KEY PLAN
NOT TO SCALE

SYSTEMS WEST ENGINEERS
725 A Street
Springfield, OR 97477
541.342.7210
systemswestengineers.com

STABILITY ENGINEERING INC.
777 NE 2ND ST. SUITE 280
P.O. BOX 2846, CORVALLIS, OR 97339
TEL.: (541)223-5560 FAX: (541)223-5278

11/13/2019

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

Pipework Bracing Plan

MARK	DATE	DESCRIPTION

DESIGNED: PS
DRAWN: PS
CHECKED: SS

DATE: 11/13/2019
PROJECT: 19-03/01

S101

MECHANICAL LEGEND

PIPING

SYMBOL	ABBREV.	DESCRIPTION
PLUMBING PIPING:		
	CW	POTABLE COLD WATER
	HW	POTABLE HOT WATER
	HWR	POTABLE HOT WATER RETURN
	TW	POTABLE TEMPERED HOT WATER
	NP	NON-POTABLE COLD WATER
	W	SANITARY WASTE
	V	VENT
HYDRONIC PIPING:		
	CWS	CHILLED WATER SUPPLY
	CWR	CHILLED WATER RETURN
	HS	HEATING WATER SUPPLY
	HR	HEATING WATER RETURN
	CD	CONDENSATE DRAIN
	CDS	CONDENSER WATER SUPPLY
	CDR	CONDENSER WATER RETURN
STEAM & CONDENSATE PIPING:		
	MPS	MEDIUM PRESSURE STEAM 15 psi-60 psi
	LPS	LOW PRESSURE STEAM <15 psi
	MPR	MEDIUM PRESSURE CONDENSATE RETURN
	LPR	LOW PRESSURE CONDENSATE RETURN
	PR	PRESSURIZED CONDENSATE RETURN

SYMBOL	ABBREV.	DESCRIPTION
		PIPING UP
		PIPING DOWN
S=0.01		SLOPE OF PIPE IN DECIMALS OF FEET
		CAPPED PIPE
		PIPE REDUCING FITTING: CONCENTRIC, ECCENTRIC
		DIRECTION OF FLOW
		UNION
		PUMP
	DV	DRAIN VALVE
	BV	BALL VALVE
	BFV	BUTTERFLY VALVE
	CHV	CHECK VALVE
	GV	GATE VALVE
	GBV	GLOBE VALVE
	AV	AUTOMATIC CONTROL VALVE: 2-WAY
	AV	AUTOMATIC CONTROL VALVE: 3-WAY
	AV	AUTOMATIC BUTTERFLY VALVE
	AV	THREE-WAY BYPASS VALVE
SV	SV	SOLENOID VALVE
PRV	PRV	PRESSURE REGULATING VALVE
		FLEXIBLE PIPE CONNECTION
		WYE STRAINER
SRV	RV	RELIEF VALVE
CFR		CONSOLIDATED FITTING RETURN
CFS		CONSOLIDATED FITTING SUPPLY
FS		WATER FLOW SWITCH
		SIGHT FLOW INDICATOR
W		SENSOR WELL
MAV		MANUAL AIR VENT
AAV		AUTOMATIC AIR VENT
		THERMOMETER
		PRESSURE GAUGE
		TEST PLUG
		STEAM TRAP
		VACUUM BREAKER (STEAM)
		VENTURI
FMS	FMS	FLOW MEASURING STATION
RP		REDUCED PRESSURE BACKFLOW PREVENTER

DUCTWORK

SYMBOL	DESCRIPTION
SA	RECTANGULAR SUPPLY AIR DUCT UP
RA	RECTANGULAR RETURN AIR DUCT UP
EA	RECTANGULAR EXHAUST AIR UP
OSA	RECTANGULAR OUTSIDE AIR UP
	RECTANGULAR SUPPLY AIR DUCT UP
	RECTANGULAR RETURN AIR DN
	RECTANGULAR EXHAUST AIR or OUTSIDE AIR DN
	ROUND DUCTWORK UP
	ROUND DUCTWORK DOWN
	TURN VANE ELBOW
	STANDARD RADIUS ELBOW
	FLEXIBLE DUCT CONNECTION
12"x6"	DUCT SIZE: WIDTH x DEPTH
SD-1 10"x10" 200	DIFFUSER TYPE SIZE - BLOW PATTERN (4-WAY IF NONE SHOWN) AIR VOLUME IN CUBIC FEET per MINUTE (CFM)
RG-1 12"x10" 175	GRILLE TYPE SIZE AIR VOLUME IN CUBIC FEET per MINUTE (CFM)
EG-1 12"x10" 175	GRILLE TYPE SIZE AIR VOLUME IN CUBIC FEET per MINUTE (CFM)
EG-1 8"x6" 100	SIDE WALL DIFFUSER OR GRILLE TYPE SIZE AIR VOLUME IN CUBIC FEET per MINUTE (CFM)
SD-2 48" - 2 - 10b 175	SLOT DIFFUSER TYPE LENGTH - # OF SLOTS - INLET SIZE AIR VOLUME IN CUBIC FEET per MINUTE (CFM)
	INTERNALLY LINED OR DOUBLE WALL DUCTWORK
	MANUAL VOLUME DAMPER
F	FIRE DAMPER
A	AUTOMATIC CONTROL DAMPER
	RECTANGULAR DUCT ANGLED CHANGE IN ELEVATION
	ROUND DUCT ANGLED CHANGE IN ELEVATION
	CONCENTRIC TRANSITION
	ECCENTRIC TRANSITION
	45 DEGREE LATERAL BRANCH, ROUND
	45 DEGREE ENTRY BRANCH, ROUND OR RECTANGULAR
	CONICAL BRANCH, ROUND

GENERAL

SYMBOL	ABBREVIATION	DESCRIPTION
(E)		EXISTING
ø OR dia		DIAMETER
Z		NEW TO EXISTING POINT OF CONNECTION
		NOTE REFERENCE MARKER
1 A101 / 1 M-021	PLAN OR DETAIL NUMBER / SHEET NUMBER	PLAN OR DETAIL REFERENCE MARKER
1 M-301	SECTION LETTER / SHEET NUMBER	SECTION REFERENCE MARKER W/VIEW DIRECTION
AHU 12 / 123	EQUIPMENT TYPE / EQUIPMENT NUMBER	EQUIPMENT MARKER
		ROOM NUMBER
		EXISTING SHOWN LIGHT
		NEW WORK SHOWN BOLD
		EXISTING TO BE REMOVED

CONTROLS

SYMBOL	DESCRIPTION
	PROCESS PIPING SIGNAL
	ELECTRICAL SIGNAL
AHU-1	SPACE SENSOR
H	SPACE HUMIDITY SENSOR
P	SPACE PRESSURE SENSOR
T	TEMPERATURE MEASUREMENT
P	PRESSURE MEASUREMENT
F	FLOW MEASUREMENT S = SENSOR T = TRANSMITTER
E	ELECTRICAL CURRENT/POWER
S C	RELAY OR SWITCH C = ELECTRIC CURRENT DP = DIFFERENTIAL PRESSURE FP = FREEZE PROTECTION M = MANUAL HP = HIGH PRESSURE LP = LOW PRESSURE
A	ACTUATOR - ELECTRIC

SYMBOL	DESCRIPTION
A	AUTOMATIC CONTROL DAMPER
FS	FLOW SWITCH
AI	BAS INPUT/OUTPUT POINT ALARM AI = ANALOG INPUT AO = ANALOG OUTPUT C = COMMUNICATION DI = DIGITAL INPUT DO = DIGITAL OUTPUT FUNCTION DESIGNATION S/S = START/STOP
CWP-2	MOTOR STARTER (W/EQUIPMENT INDICATED UNDERLINE)
VFD CWP-2	EQUIPMENT CONTROL PANEL (W/EQUIP. INDICATED UNDERLINED) BCP = BOILER CONTROL PANEL CP = CONTROL PANEL VFD = VARIABLE FREQUENCY DRIVE FAP = FIRE ALARM PANEL CCP = CHILLER CONTROL PANEL

ABBREVIATIONS

A/CH	AIR CHANGES PER HOUR	IN	INCHES
A/FF	ABOVE FINISHED FLOOR	IN WC	INCHES WATER COLUMN
AFS	AUTOMATIC FIRE SPRINKLER	IPLV	INTEGRATED PART LOAD VALUE
AL	ALUMINUM	IW	INDIRECT WASTE
ALT	ALTERNATE	LAT	LEAVING AIR TEMPERATURE
APD	AIR PRESSURE DROP	LBS	POUNDS
BAS	BUILDING AUTOMATION SYSTEM	LWT	LEAVING WATER TEMPERATURE
BHP	BRAKE HORSEPOWER	Ma	MILLIAMPERE
BOD	BOTTOM OF DUCT	MAX	MAXIMUM
BTUH	BRITISH THERMAL UNITS PER HOUR	MBH	THOUSAND BTUs per HOUR
CFH	CUBIC FEET per HOUR	MCA	MINIMUM CIRCUIT AMPS
CFM	CUBIC FEET per MINUTE	MFGR	MANUFACTURER
CMU	CONCRETE MASONRY UNIT	MIN	MINIMUM
CONC	CONCRETE	MOP	MAX. OVERCURRENT PROTECTION
CONT	CONTINUATION	NC	NOISE CRITERIA
DB	DRY BULB	NC	NORMALLY CLOSED
Dba	DECIBELS ACOUSTIC	NIC	NOT IN CONTRACT
DN	DOWN	NO	NORMALLY OPEN
DP	DIFFERENTIAL PRESSURE	NPLV	NON-STANDARD PART LOAD VALUE
EAT	ENTERING AIR TEMPERATURE	NPSH	NET POSITIVE SUCTION HEAD
EER	ENERGY EFFICIENCY RATIO	OFCI	OWNER FURNISHED/ CONTRACTOR INSTALLED
EFF	EFFICIENCY	PD	PRESSURE DROP
ESP	EXTERNAL STATIC PRESSURE	PH	PHASE
EWT	ENTERING WATER TEMPERATURE	PPH	POUNDS per HOUR
FLA	FULL LOAD AMPS	PSI	POUNDS per SQUARE INCH GAUGE
FPM	FEET PER MINUTE	REQ'D	REQUIRED
FT	FEET	RF	RETURN FAN
FT WC	FEET WATER COLUMN	RH	RELATIVE HUMIDITY
FUT	FUTURE	RPM	REVOLUTIONS per MINUTE
GPH	GALLONS PER HOUR	SEER	SEASONAL ENERGY EFFICIENCY RATIO
GPM	GALLONS PER MINUTE	SF	SUPPLY FAN
GYP BD	GYPSUM WALL BOARD	SS	STAINLESS STEEL
HP	HORSEPOWER	STL	STEEL
HSPF	HEATING SEASONAL PERFORMANCE FACTOR	TSP	TOTAL STATIC PRESSURE
HVAC	HEATING, VENTILATING, & AIR CONDITIONING	TYP	TYPICAL
		VFD	VARIABLE FREQUENCY DRIVE
HZ	HERTZ (CYCLES PER SECOND)	WB	WET BULB
IAQ	INDOOR AIR QUALITY	WC	WATER COLUMN
IE	INVERT ELEVATION	WG	WATER GAUGE

GENERAL NOTES

1. THE FACILITY WILL REMAIN IN OPERATION DURING CONSTRUCTION. COORDINATE ALL SHUTDOWNS AND CONSTRUCTION ACTIVITY WITH FACILITIES STAFF.
2. SIZE AND LOCATION OF ALL PIPING AND OTHER MECHANICAL EQUIPMENT IS APPROXIMATE. CONTRACTOR SHALL SITE VERIFY THE LOCATION OF EXISTING PIPING AND EQUIPMENT AND CONSTRUCT WORK FROM FIELD DIMENSIONS. CONTRACTOR SHALL MAKE ADJUSTMENTS NECESSARY TO ACCOMMODATE MINOR DEVIATIONS AT NO COST TO OWNER.
3. FINE (LIGHT) LINE WORK INDICATES EXISTING PIPING AND OTHER MECHANICAL EQUIPMENT. BOLD (HEAVY) LINE WORK INDICATES NEW PIPING AND OTHER MECHANICAL EQUIPMENT.
4. IT IS RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE CUTTING AND PATCHING TO ALLOW THE INSTALLATION OF MATERIALS AND EQUIPMENT AS SPECIFIED AND SHOWN ON DRAWINGS.

EXISTING CONDITIONS/DEMOLTION NOTES

1. EXISTING CONDITIONS BASED ON EXISTING RECORD DRAWINGS AND LIMITED SITE VERIFICATION. CONTRACTOR TO VERIFY FULL EXTENT OF EXISTING CONDITIONS PRIOR TO STARTING WORK.
2. EQUIPMENT, DUCTWORK, AND PIPING REMOVAL INCLUDES HANGERS, SUPPORTS, AND APPURTENANCES.
3. EQUIPMENT REMOVAL INCLUDES ALL VESTIGES OF EXISTING PNEUMATIC CONTROLS COMPONENTS AND PERIPHERALS. PNEUMATIC CONTROLS REMOVAL INCLUDES, BUT NOT LIMITED TO THE FOLLOWING: COMPRESSED AIR TUBING, THERMOSTATS, SWITCHES, PNEUMATIC CONTROLLERS, AND DAMPER OPERATORS. NOT ALL COMPONENTS WHICH MUST BE REMOVED ARE INDICATED ON DRAWINGS.

SHEET INDEX - MECHANICAL

SYSTEMS WEST ENGINEERS
725 A Street
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systemswestengineers.com

REGISTERED PROFESSIONAL ENGINEER — OREGON — JAN. 11, 2005 — PAUL E. FOLKS — RENEWS: 12-31-19 — DIGITALLY SIGNED

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

LEGEND, GENERAL NOTES & SHEET INDEX

MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: JSH
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

M001

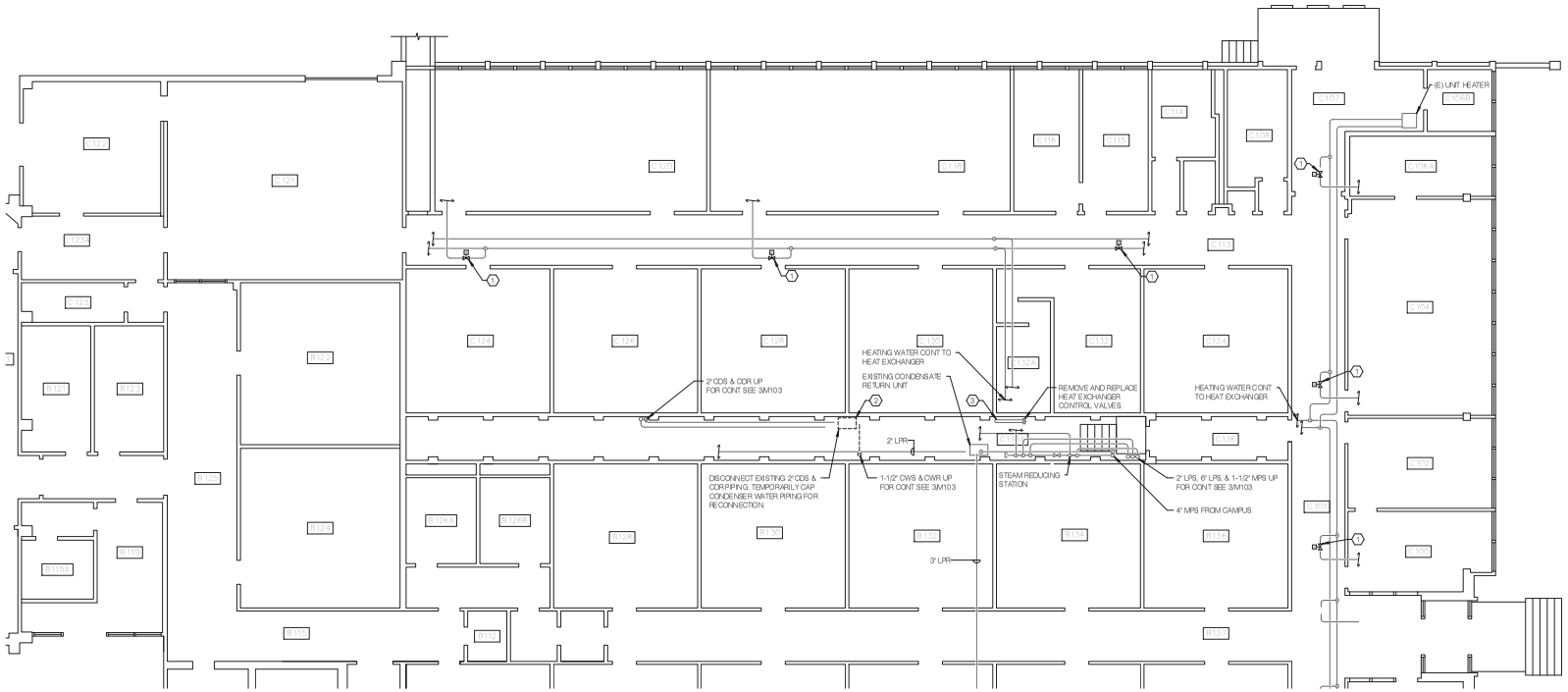
PLOTTED BY: JSH ON: 11/15/2019 8:09:00 AM

SHEET NOTES:

1. DRAWINGS DO NOT DEPICT FULL EXTENT OF EXISTING CONDITIONS. CONTRACTOR TO FIELD VERIFY EXISTING CONDITIONS PRIOR TO BEGINNING WORK.
2. REMOVAL OF EQUIPMENT, PIPING, & VALVES INCLUDES ASSOCIATED HANGERS, SUPPORTS, AND APPURTENANCES.

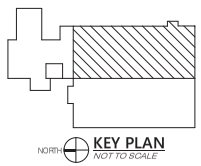
REFERENCE NOTES:

1. REMOVE HEATING WATER CONTROL VALVE. TEMPORARILY CAP PIPE FOR RECONNECTION TO NEW CONTROL VALVE IN SAME LOCATION. REMOVE ASSOCIATED PNEUMATIC CONTROLS COMPONENTS.
2. REMOVE CHILLER LOCATED ON LOWER LEVEL OF UTILITY TUNNEL. REMOVE ASSOCIATED CHILLED WATER PUMP, CHILLED WATER PIPING, & CONTROLS. REMOVE PNEUMATIC CONTROLS TUBING BACK TO ACTIVE MAIN AND CAP.
3. MAIN ISOLATION VALVES FOR EAST AND SOUTH HEATING WATER PIPING LOCATED ON UPPER LEVEL OF UTILITY TUNNEL, DIRECTLY ABOVE HEAT EXCHANGER. HEAT EXCHANGER CAPACITY APPROXIMATELY 350 MBH.



NORTH

1 DEMOLITION PLAN - LOWER LEVEL EAST
1/8" = 1'-0"



NORTH KEY PLAN
NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER
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JAN. 11, 2005
PAUL E. FOWKS
RENEWAL: 6-30-21

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

DEMOLITION PLAN - LOWER LEVEL EAST

MARK	DATE	DESCRIPTION

DESIGNED:	TKO
DRAWN:	TKO
CHECKED:	PEF
DATE:	11/13/2019
PROJECT:	T049.11

M101

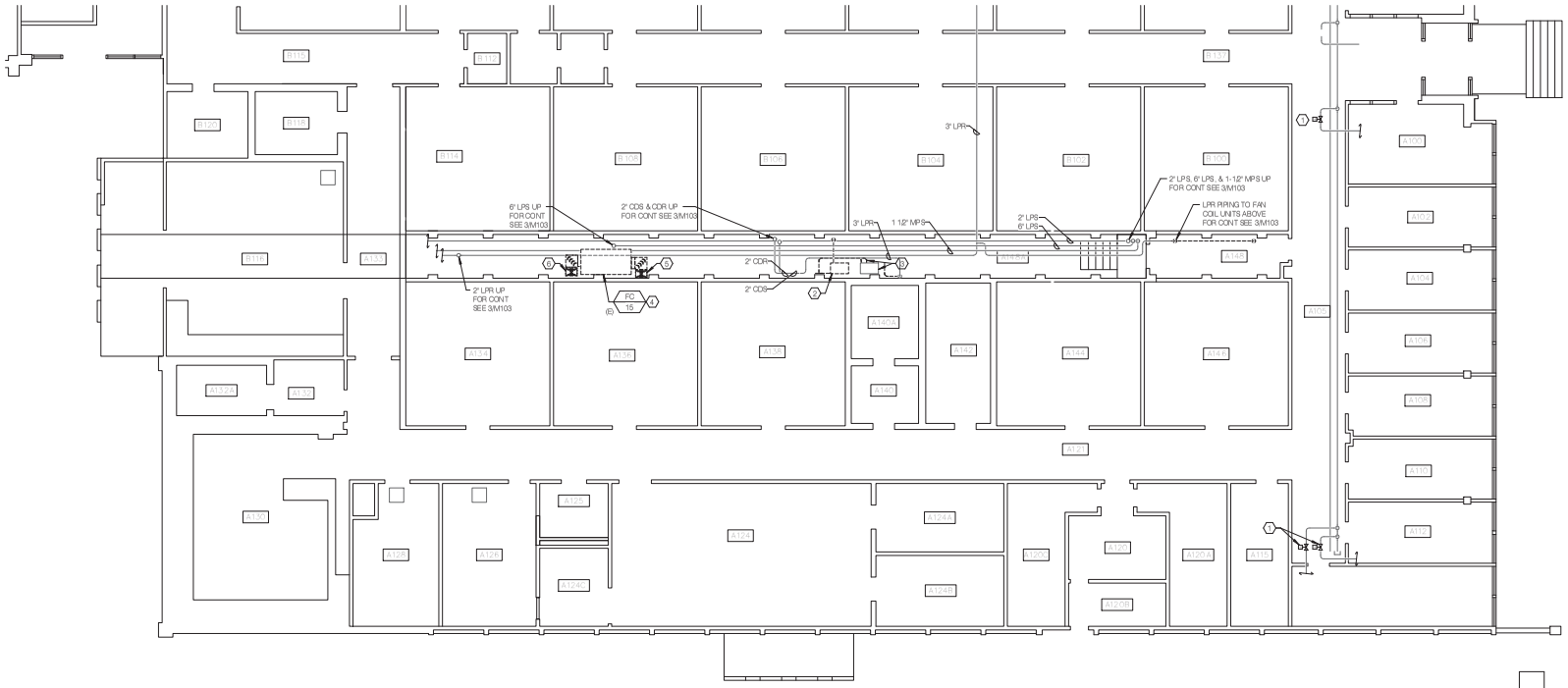
PLOTTED BY: TKO ON: 11/14/2019 4:56:51 PM

SHEET NOTES:

1. DRAWINGS DO NOT DEPICT FULL EXTENT OF EXISTING CONDITIONS. CONTRACTOR TO FIELD VERIFY EXISTING CONDITIONS PRIOR TO BEGINNING WORK.
2. REMOVAL OF EQUIPMENT, PIPING, & VALVES INCLUDES ASSOCIATED HANGERS, SUPPORTS, AND APPURTENANCES.

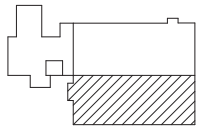
REFERENCE NOTES:

1. REMOVE HEATING WATER CONTROL VALVE. TEMPORARILY CAP PIPE FOR RECONNECTION TO NEW CONTROL VALVE IN SAME LOCATION.
2. REMOVE CHILLER LOCATED ON PLATFORM IN LOWER LEVEL OF UTILITY TUNNEL. REMOVE ASSOCIATED CHILLED WATER PUMP, CHILLED WATER PIPING, & CONTROLS. REMOVE PNEUMATIC CONTROLS TUBING BACK TO ACTIVE MAIN AND CAP.
3. EXISTING WATER COOLED REFRIGERATION UNITS LOCATED ON PLATFORM IN LOWER LEVEL OF UTILITY TUNNEL TO REMAIN. NEW CONDENSER WATER PUMPS WILL BE PROVIDED FOR EACH UNIT. REMOVE CDS & CDR PIPING AS NEEDED TO ACCOMMODATE INSTALLATION OF NEW PUMPS. SEE CONDENSER WATER DIAGRAM, 2/M611 FOR DETAILS.
4. REMOVE FAN COIL UNIT LOCATED ON LOWER LEVEL OF UTILITY TUNNEL. REMOVE STEAM & CONDENSATE PIPING BACK TO ACTIVE MAIN AND CAP. REMOVE ASSOCIATED CONTROLS AND PNEUMATIC CONTROLS TUBING. CAP PNEUMATIC TUBING AT ACTIVE MAIN.
5. REMOVE INLET DUCTWORK TO FAN COIL UNIT BACK TO TOP OF DUCT DROP LOCATED AT UPPER LEVEL OF UTILITY TUNNEL. REMAINING DUCTWORK TO REMAIN FOR RECONNECTION TO NEW DUCTWORK. FOR CONT SEE 1/M103
6. REMOVE OUTLET DUCTWORK FROM FAN COIL UNIT TO WEST WALL PENETRATION AT UPPER LEVEL OF UTILITY TUNNEL. EXISTING DUCTWORK CONTINUING THROUGH WALL TO REMAIN FOR RECONNECTION TO NEW DUCTWORK. FOR CONT SEE 1/M103



NORTH

1 DEMOLITION PLAN - LOWER LEVEL WEST
1/8" = 1'-0"



NORTH KEY PLAN
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OREGON
JAN. 11, 2005
PAUL E. FOUKS
RENEWS: 12-31-19

Cooling Design

Radiation Center

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3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

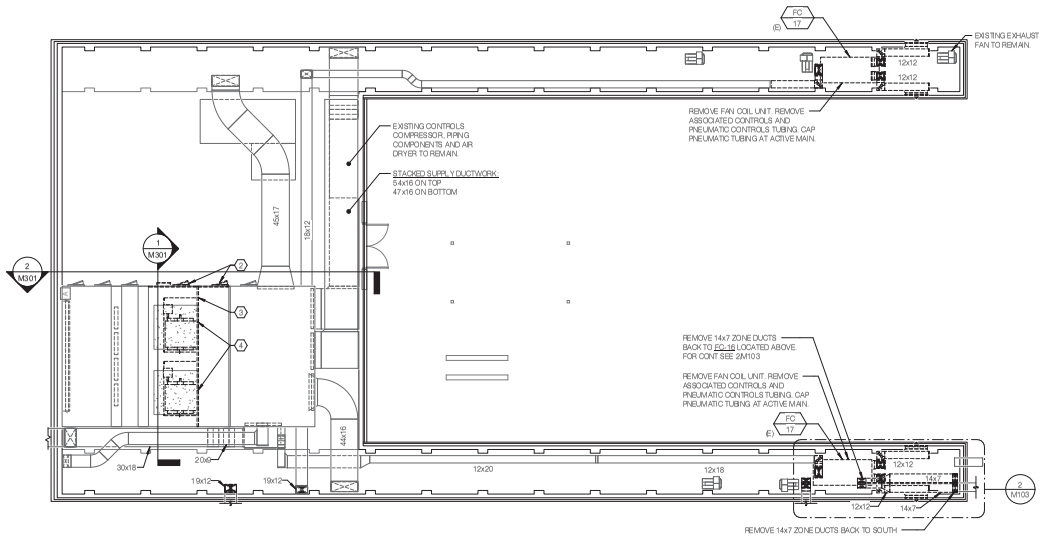
DEMOLITION PLAN - LOWER LEVEL WEST

MARK	DATE	DESCRIPTION

DESIGNED:	TKO
DRAWN:	JSH
CHECKED:	PEF
DATE:	11/13/2019
PROJECT:	T049.11

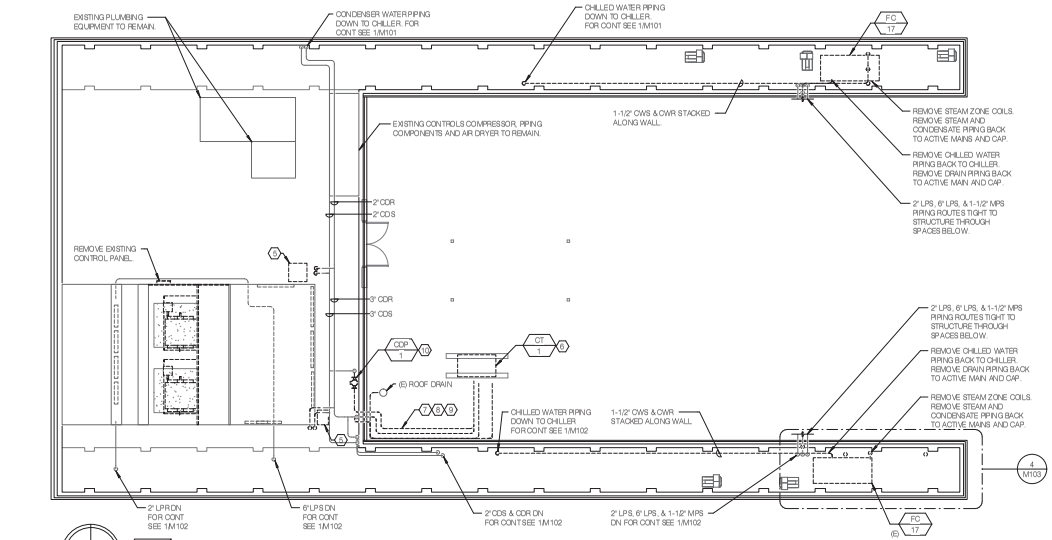
M102

PLOTTED BY: JSH ON: 11/14/2019 4:56:53 PM



NORTH

1 AIR DISTRIBUTION DEMOLITION PLAN - UPPER LEVEL & ROOF
1/8" = 1'-0"



NORTH

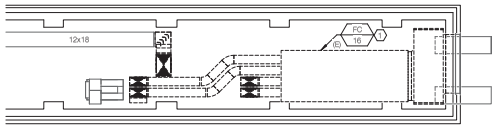
3 PIPING DEMOLITION PLAN - UPPER LEVEL & ROOF
1/8" = 1'-0"

SHEET NOTES:

1. DRAWINGS DO NOT DEPICT FULL EXTENT OF EXISTING CONDITIONS. CONTRACTOR TO FIELD VERIFY EXISTING CONDITIONS PRIOR TO BEGINNING WORK.
2. REMOVAL OF EQUIPMENT, PIPING, & VALVES INCLUDES ASSOCIATED HANGERS, SUPPORTS, AND APPURTENANCES.

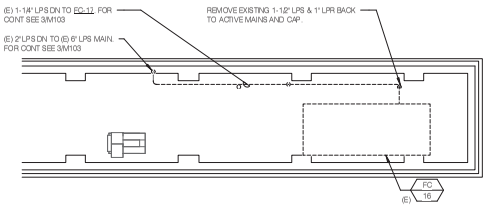
REFERENCE NOTES:

1. REMOVE FAN COIL UNIT LOCATED ON PLATFORM ABOVE UPPER LEVEL OF UTILITY TUNNEL. REMOVE ASSOCIATED CONTROLS AND PNEUMATIC CONTROLS TUBING. REMOVE OUTSIDE AIR PLENUM AND OSA DAMPER. EXTERIOR LOUVER TO REMAIN FOR RECONNECTION TO NEW FAN COIL UNIT.
2. REMOVE AIR HANDLER WALLS AND DOORS TO ACCOMMODATE REMOVAL OF FANS AND INSTALLATION OF NEW FANS AND COOLING COIL.
3. REMOVE AIR HANDLER PARTITION WALL AT FAN DISCHARGE.
4. REMOVE AND REPLACE SUPPLY FANS, (TYP. of 2). CONCRETE PADS TO REMAIN.
5. REMOVE WATER-COOLED CONDENSING UNIT LOCATED NEXT TO AIR HANDLER. REMOVE CONDENSER WATER PIPING BACK TO ACTIVE MAIN ABOVE AND CAP. REMOVE ASSOCIATED ZONE DX COIL LOCATED IN AIR HANDLER DISCHARGE PLENUM. REMOVE ALL REFRIGERANT PIPING, CONTROLS, & CONTROL WIRING ASSOCIATED TO CONDENSING UNIT AND DX COIL.
6. REMOVE COOLING TOWER. REMOVE ASSOCIATED FAN, SPRAY PUMP, SUMP HEATER, CONTROLS AND CONTROL WIRING.
7. CAUTION: ALTHOUGH PIPING IS NOT LABELED, THERE IS HEAT TRACE ON EXTERIOR CDS, CDR, & CW PIPE. CONTRACTOR TO CONFIRM ALL POWER IS DISCONNECTED TO HEAT TRACE PRIOR TO BEGINNING WORK REMOVING EXTERIOR 3" CDS, 3" CDR, 5/8" CW, & 2" D EXTERIOR PIPING.
8. REMOVE 3"CDS, 3" CDR, & 5/8" CW PIPING FROM COOLING TOWER TO JUST INSIDE MECHANICAL ROOM. TEMPORARILY CAP 3" CDR AND 5/8" CW PIPE FOR RECONNECTION TO NEW.
9. REMOVE ROOF PIPE SUPPORTS.
10. REMOVE CONDENSER WATER PUMP. REMOVE ASSOCIATED CONTROLS AND CONTROL WIRING. REMOVE CDS PIPING AND COMPONENTS FROM EXTERIOR WALL PENETRATION TO 2'-0" PAST ISOLATION VALVE ON DISCHARGE SIDE OF PUMP. TEMPORARILY CAP CDS PIPE INSIDE AND CHEMICAL BY-PASS FOR RECONNECTION TO NEW PUMP AND PIPING.



NORTH

2 AIR DISTRIBUTION DEMOLITION PLAN - UPPER PLATFORM WEST UTILITY TUNNEL
1/4" = 1'-0"



NORTH

4 PIPING DEMOLITION PLAN - UPPER PLATFORM WEST UTILITY TUNNEL
1/4" = 1'-0"

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OREGON
JAN. 11, 2005
PAUL E. FOOKS
RENEWS: 6-30-20

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

DEMOLITION PLANS - UPPER LEVEL & ROOF

MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: TKO
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

M103

PLOTTED BY: TKO ON: 11/14/2019 4:56:54 PM

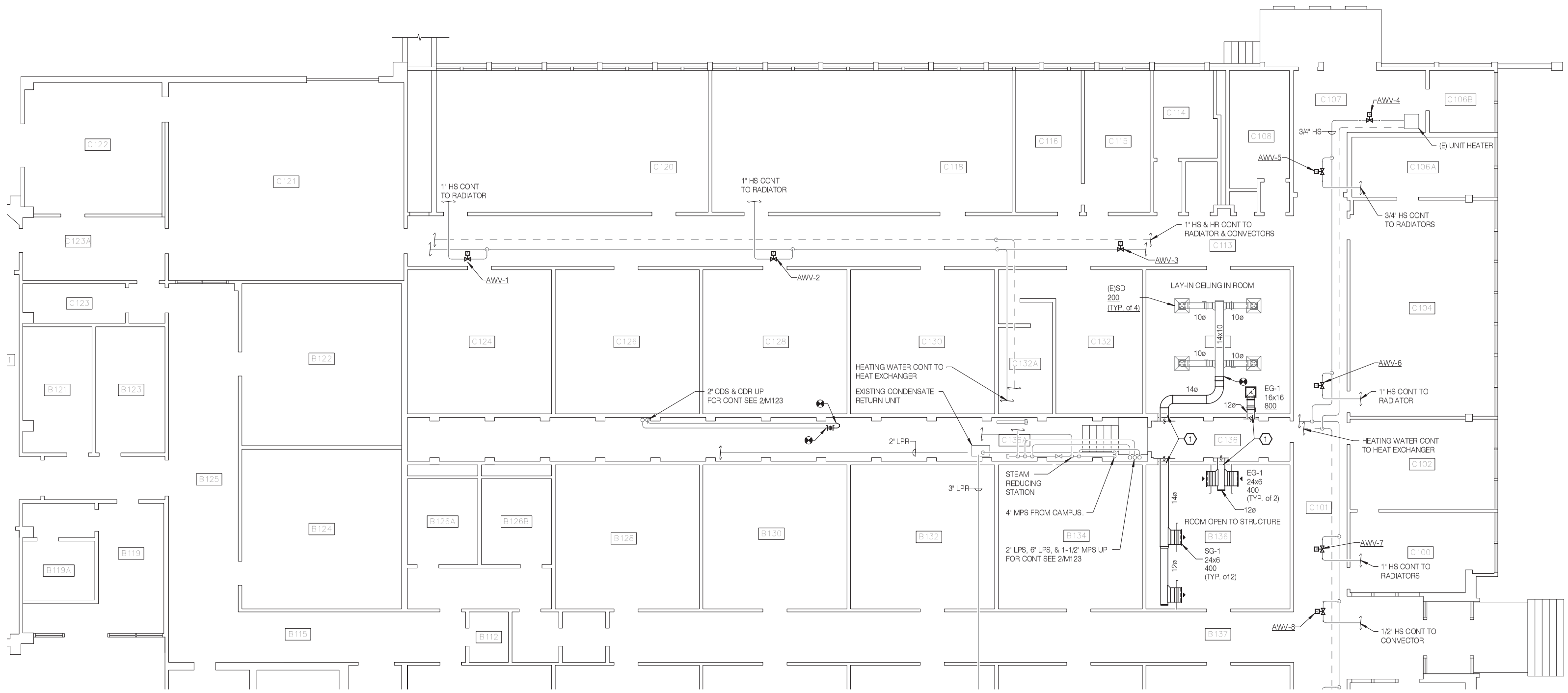
PLOTTED BY TKO ON: 11/15/2019 8:09:02 AM

SHEET NOTES:

1. FLUSH HEATING WATER SYSTEM PRIOR TO INSTALLATION OF NEW CONTROL VALVES.
2. SEE 4/M521 FOR CONTROL VALVE INSTALLATION DETAIL.

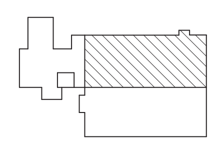
REFERENCE NOTES:

(1) SEE 4/M522 FOR WALL PENETRATION DETAIL.



NORTH

1 MECHANICAL PLAN - LOWER LEVEL EAST
1/8" = 1'-0"



NORTH KEY PLAN
NOT TO SCALE

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JAN. 11, 2005
PAUL E. FOOKS

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MECHANICAL PLAN - LOWER LEVEL EAST

MARK	DATE	DESCRIPTION

DESIGNED:	TKO
DRAWN:	TKO
CHECKED:	PEF
DATE:	11/13/2019
PROJECT:	T049.11

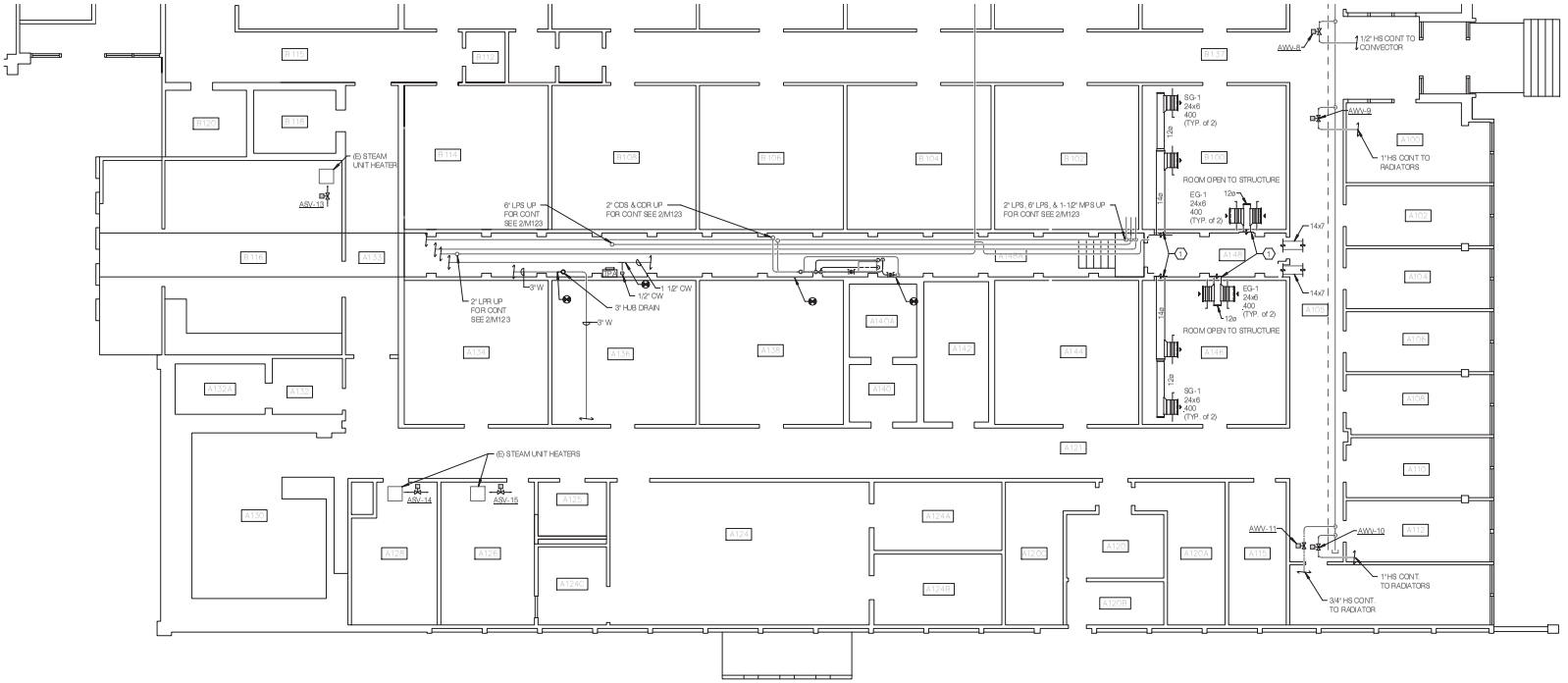
M121

SHEET NOTES:

1. FLUSH HEATING WATER SYSTEM PRIOR TO INSTALLATION OF NEW CONTROL VALVES.
2. SEE 4/M521 FOR CONTROL VALVE INSTALLATION DETAIL.

REFERENCE NOTES:

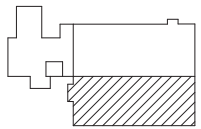
(1) SEE 4/M522 FOR WALL PENETRATION DETAIL.



NORTH

1 MECHANICAL PLAN - LOWER LEVEL WEST

1/8" = 1'-0"



NORTH KEY PLAN NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER
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OREGON
JAN. 11, 2005
PAUL E. FOWLS
RENEWS: 12-31-19

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MECHANICAL PLAN - LOWER LEVEL WEST

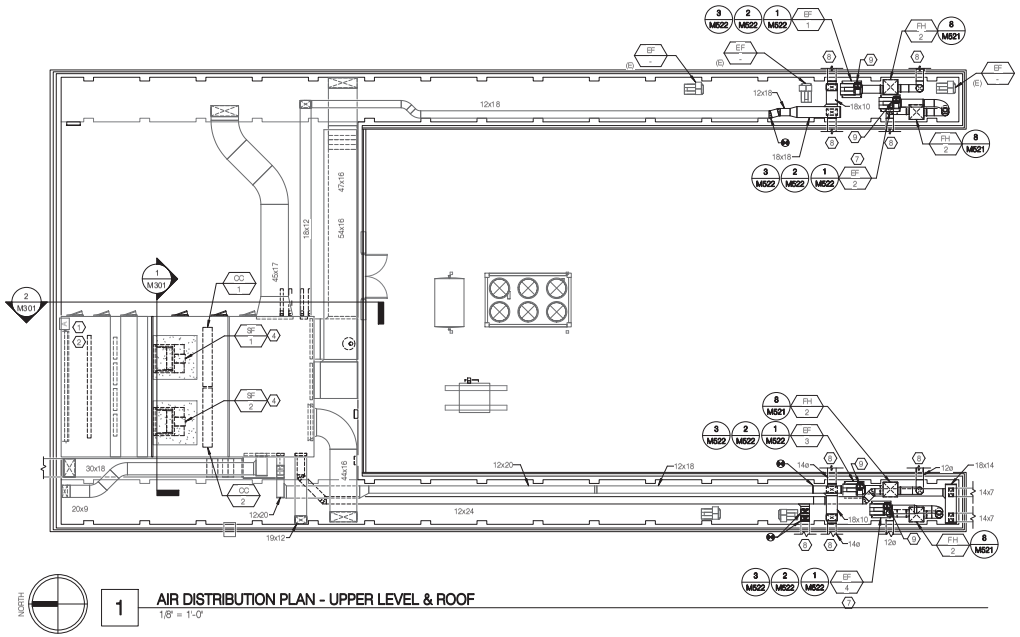
MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: TKO
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

M122

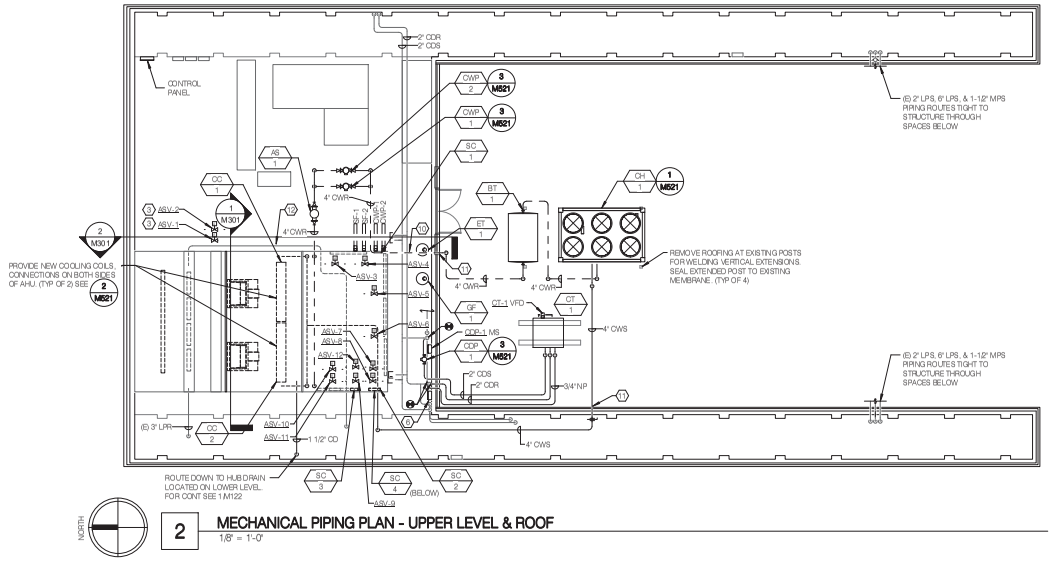
PLOTTED BY: TKO ON: 11/15/2019 8:09:04 AM



NORTH

1 AIR DISTRIBUTION PLAN - UPPER LEVEL & ROOF

1/8" = 1'-0"



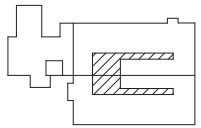
NORTH

2 MECHANICAL PIPING PLAN - UPPER LEVEL & ROOF

1/8" = 1'-0"

REFERENCE NOTES:

1. REMOVE AND REPLACE EXISTING PNEUMATIC DAMPER OPERATOR WITH NEW BAS ACTUATOR.
2. SERVICE EXISTING DAMPER AND VERIFY OPERATION THROUGH FULL RANGE OF MOTION. LUBRICATE LINKAGE POINTS AND STRAIGHTEN DRIVE COMPONENTS AS REQUIRED TO ACHIEVE FULL STROKE AND TIGHT SHUTOFF.
3. REPLACE AIR HANDLER STEAM PRE-HEAT COIL CONTROL VALVES.
4. REUSE CONCRETE INERTIA BASES FOR SF-1 & SF-2. CONSTRUCT NEW PLENUM WALL AROUND FANS.
5. REMOVE AND REPLACE EXISTING PRE-FILTER RACK.
6. HEAT TRACE CONTROLLER ON WALL.
7. INSTALL EXHAUST FAN APPROXIMATELY 7'-6" ABOVE FLOOR WITH SUPPORTS SPANNING TUNNEL WALLS.
8. PROVIDE NEW DUCT PENETRATION THROUGH EXISTING CMU WALL. FOR DETAILS SEE 4/M522.
9. 12"Ø EA UP THROUGH ROOF. PROVIDE NEW DUCT PENETRATION THROUGH EXISTING METAL DECK ROOF FOR EXHAUST DUCT RISER. SEE 6/M522 FOR ROOF PENETRATION DETAIL.
10. 4" CWR PIPE LOCATED HIGH WITHIN EXISTING OPEN WEB ROOF FRAMING.
11. PROVIDE NEW WALL PENETRATION FOR CHILLED WATER PIPING. EXISTING WALL CONSIST OF CORGATED METAL EXTERIOR AND CMU WALL. PROVIDE WATER TIGHT SEAL AT WALL PENETRATION. SEE 5/M22
12. COORDINATE REPLACEMENT OF AIR HANDLER PRE-HEAT CONTROL VALVES & TEMPORARY STEAM MAIN REMOVAL IN FRONT OF AIR HANDLER WITH REPLACEMENT OF SUPPLY FANS & INSTALLATION OF NEW COOLING COILS.



NORTH KEY PLAN
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JAN. 11, 2005
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RENEWS: 12/31/19

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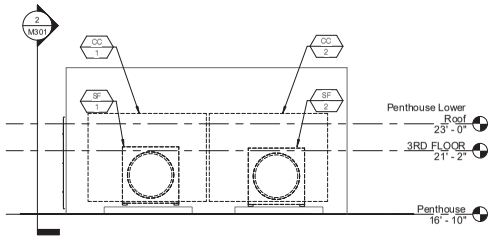
MECHANICAL PLANS - UPPER LEVEL & ROOF

MARK	DATE	DESCRIPTION

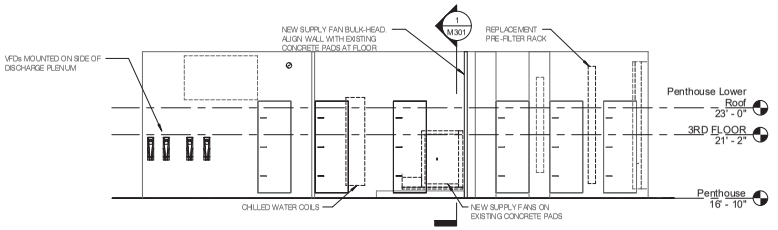
DESIGNED:	TKO
DRAWN:	JSH
CHECKED:	PEF
DATE:	11/13/2019
PROJECT:	T049.11

M123

PLOTTED BY: JSH ON: 11/15/2019 8:09:07 AM



1 SECTION 1
1/4" = 1'-0"



2 SECTION 2
1/4" = 1'-0"

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SECTIONS

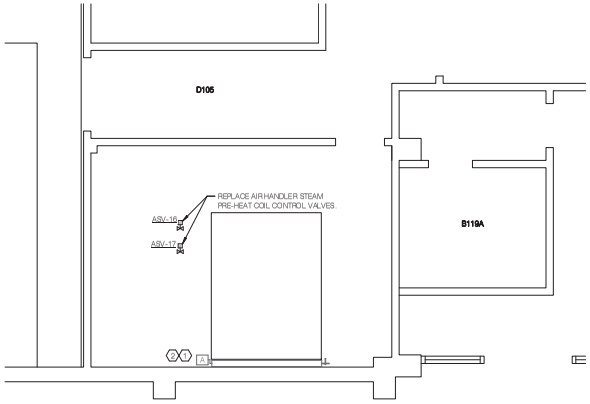
MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: JSH
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

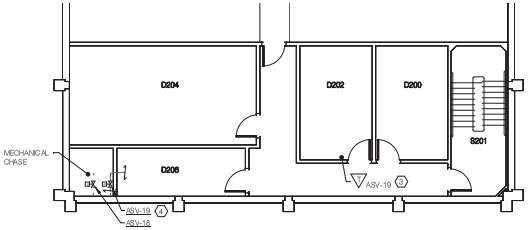
M301

PLOTTED BY: JSH ON: 11/14/2019 4:57:03 PM



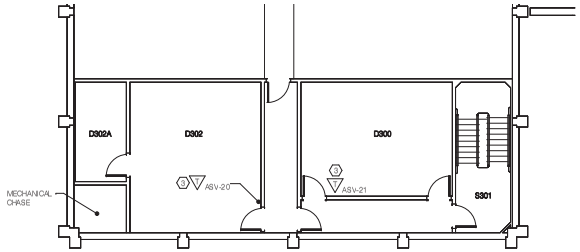
1 MECHANICAL ENLARGED PLAN - REACTOR BUILDING MECHANICAL ROOM

NOT TO SCALE



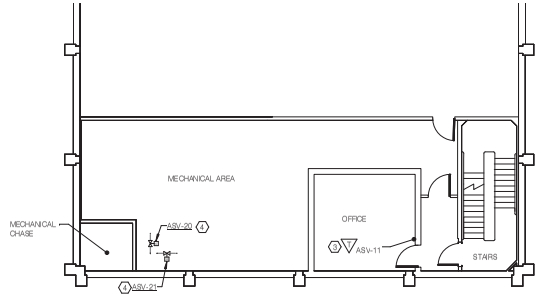
2 2ND FLOOR

NOT TO SCALE



3 3RD FLOOR

NOT TO SCALE

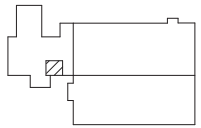


4 4TH FLOOR

NOT TO SCALE

REFERENCE NOTES:

1. REMOVE AND REPLACE EXISTING PNEUMATIC DAMPER OPERATOR WITH NEW BAS ACTUATOR.
2. SERVICE EXISTING DAMPER AND VERIFY OPERATION THROUGH FULL RANGE OF MOTION. LUBRICATE LINKAGE POINTS AND STRAIGHTEN DRIVE COMPONENTS, AS REQUIRED TO ACHIEVE FULL STROKE AND TIGHT SHUTOFF.
3. REMOVE EXISTING SPACE THERMOSTAT AND INSTALL NEW SPACE TEMPERATURE SENSOR AT SAME LOCATION.
4. REMOVE CONTROL VALVE AND PNEUMATIC ACTUATOR FOR EXISTING STEAM ZONE COIL. INSTALL NEW VALVE AND BAS ACTUATOR FOR EXISTING ZONE COIL AT SAME LOCATION.



NORTH KEY PLAN

NOT TO SCALE

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Springfield, OR 97477
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REGISTERED PROFESSIONAL ENGINEER
DIGITALLY SIGNED
OREGON
PAUL E. FOLKS
EXPIRES: 12-31-19

Cooling Design

Radiation Center

LOCATION:
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MECHANICAL ENLARGED PLANS

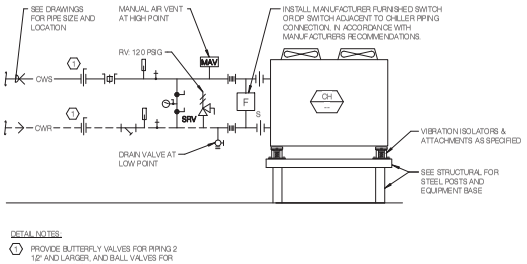
MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: TKO
CHECKED: PEF

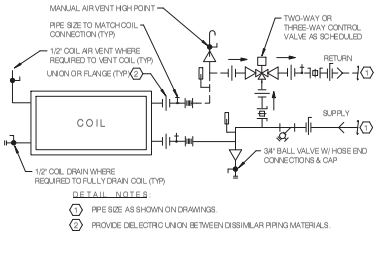
DATE: 11/13/2019
PROJECT: T049.11

M421

PLOTTED BY: TKO ON: 11/14/2019 4:57:04 PM



1 AIR - COOLED CHILLER
NOT TO SCALE



2 COOLING COIL
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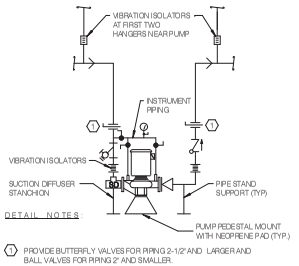

3 IN-LINE CIRCULATION PUMP
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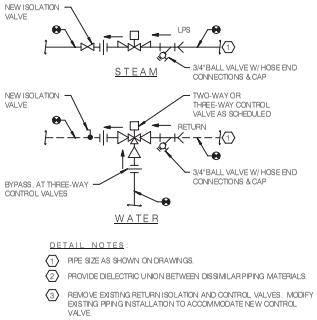

4 CONTROL VALVE INSTALLATION
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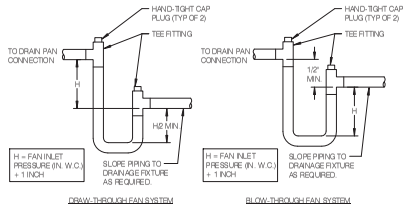

5 CONDENSATE DRAIN CONNECTION
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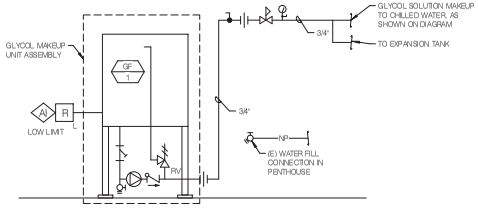
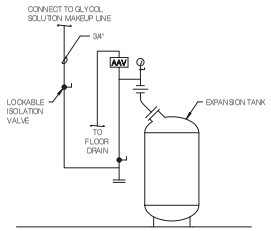


6 GLYCOL FEEDER
NOT TO SCALE



7 EXPANSION TANK
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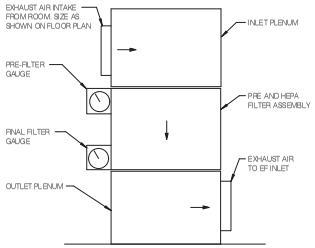

8 EXHAUST FILTER HOUSING
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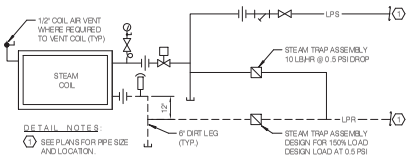
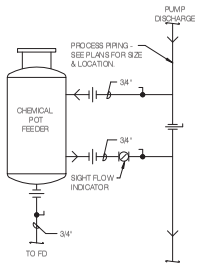


9 STEAM HEATING COIL PIPING
NOT TO SCALE



10 CHEMICAL POT FEEDER
NOT TO SCALE

SYSTEMS WEST ENGINEERS
725 A Street
Springfield, OR 97477
541.342.7210
systemswestengineers.com

REGISTERED PROFESSIONAL ENGINEER
DIGITALLY SIGNED
OREGON
JAN. 11, 2005
PAUL E. FOLKS
RENEWS: 12-31-19

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

DETAILS

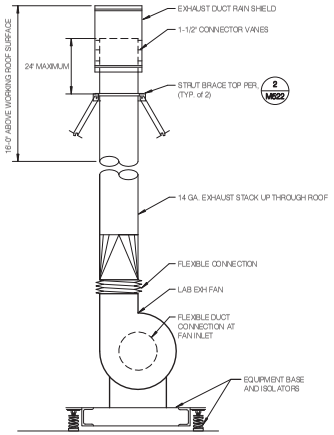
MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: JSH
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

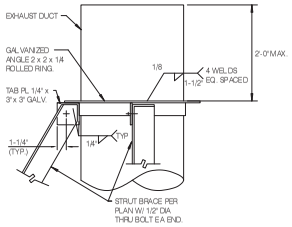
M521

PLOTTED BY: JSH ON: 11/15/2019 8:40:55 AM



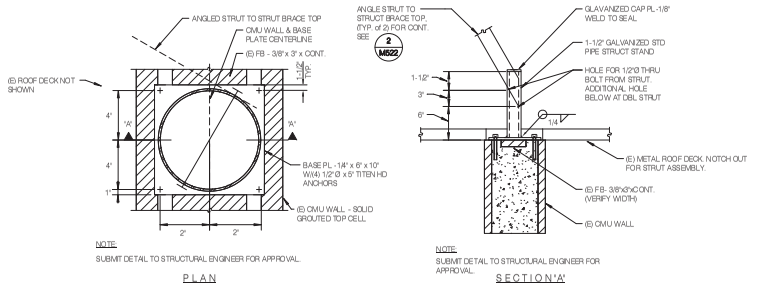
1 EXHAUST FAN STACK

NOT TO SCALE



2 STRUT BRACE TOP CONNECTION

NOT TO SCALE



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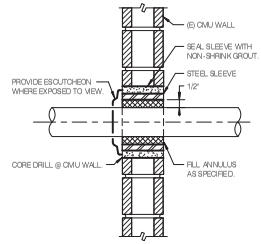
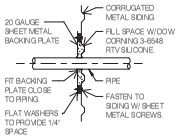
NOT TO SCALE



4 DUCT & PIPE CMU WALL PENETRATION

NOT TO SCALE



5 CORRUGATED METAL WALL PENETRATION

NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER
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OREGON
JAN. 11, 2005
PAUL E. FOLKS
RENEWS: 12-31-20

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

DETAILS

MARK	DATE	DESCRIPTION

DESIGNED:	TKO
DRAWN:	TKO
CHECKED:	PEF
DATE:	11/13/2019
PROJECT:	T049.11

M522

PLOTTED BY: TKO ON: 11/14/2019 4:57:04 PM

COOLING TOWER

TAG	MANUFACTURER	MODEL	SERVICE	AMBIENT WB (°F)	CONDENSER WATER PERFORMANCE				MAKEUP WATER FLOW (GPM)	SPRAY PUMP			FAN			SUMP HEATER			ELECTRICAL				OPERATING WEIGHT (LBS)	REMARKS
					FLOW (GPM)	EWT (°F)	LWT (°F)	MAX PD (PSI)		VOLTS	PHASE	HP	VOLTS	PHASE	HP	VOLTS	PHASE	KW	VOLTS	PHASE	FLA	MOTOR CONTROL (1)(2)		
CT-1	EVAPCO	ATWB 4-5P4-Z	CONDENSER WATER	73	24	95	85	2.00	2	208	3	0.75	208	3	3	208	3	2	208	3	15	VFD	3800	

(1) MOTOR CONTROL FURNISHED BY DIV. 23.
(2) MS - MOTOR STARTER, VFD - VARIABLE FREQUENCY DRIVE, ECM - ECM MOTOR CONTROLLER, CR - CONTROL RELAY

AIR COOLED CHILLER

TAG	MANUFACTURER	MODEL	SERVICE	OUTDOOR AMBIENT (°F)	NOMINAL CAPACITY (TONS)	COMPRESSOR		EVAPORATOR				PERFORMANCE		ELECTRICAL				REMARKS
						QTY	TYPE	EWT (°F)	LWT (°F)	DESIGN FLOW (GPM)	MIN FLOW (GPM)	MAX PD (FT)	IPLV (1)	EER (2)	OPERATING WEIGHT (LBS)	AMBIENT SOUND (dbA)	VOLTS	PHASE	MCA (3)	MOP (4)	
CH-1	CARRIER	30HB-110	CHILLED WATER	95	110	6	ROTARY SCROLL	45	60	175	175	6	16.71	9.82	6100	100	208	3	808	600	

(1) IPLV PERFORMANCE BASED ON AHRI 550/590 STANDARD CONDITIONS.
(2) ENERGY EFFICIENCY RATIO AT DESIGN LOAD CONDITIONS.
(3) MINIMUM CIRCUIT AMPACITY.
(4) MAXIMUM OVERCURRENT PROTECTION.

PUMP

TAG	MANUFACTURER	MODEL	SERVICE	TYPE	FLOW (GPM)	TOTAL HEAD (FT)	MIN. EFF (%)	BHP	MOTOR				MOTOR CONTROL (1) (2)	REMARKS
									VOLTS	PHASE	RPM	HP		
CDP-1	TACO	1615	CONDENSER WATER	IN-LINE	24.00	40	45	0.53	208	3	1760	1	MS	
CWP-1	TACO	KV3009	CHILLED WATER	IN-LINE	175.00	50	60	3.59	208	3	1760	5	VFD	CHILLED WATER W/ 30% PROPYLENE GLYCOL
CWP-2	TACO	KV3009	CHILLED WATER	IN-LINE	175.00	50	60	3.59	208	3	1760	5	VFD	CHILLED WATER W/ 30% PROPYLENE GLYCOL

(1) MOTOR CONTROL FURNISHED BY DIV. 23.
(2) MS - MOTOR STARTER, VFD - VARIABLE FREQUENCY DRIVE, ECM - ECM MOTOR CONTROLLER, CR - CONTROL RELAY

CHILLED WATER COIL

TAG	LENGTH (IN)	HEIGHT (IN)	AIRFLOW (CFM)	COOLING CAPACITY								MAX FINS PER INCH	MAX PD (FT)	CONTROL VALVE		RUNOUT SIZE (IN)	REMARKS
				EAT DB (°F)	EAT WB (°F)	LAT DB (°F)	LAT WB (°F)	EWT (°F)	LWT (°F)	FLOW (GPM)	NUMBER OF ROWS			TYPE	MAX PD (FT)		
CC-1	84	72	16000	95.0	68.0	59.1	55.5	45.0	60.0	87.5	4	0.30	10	19	3-WAY	12.5	3.0	
CC-2	84	72	16000	95.0	68.0	59.1	55.5	45.0	60.0	87.5	4	0.30	10	19	3-WAY	12.5	3.0	

STEAM COIL

TAG	HEIGHT (IN)	LENGTH (IN)	AIRFLOW (CFM)	HEATING CAPACITY				MAX PD (IN)	ASSOCIATED CONTROL VALVE	RUNOUT SIZE (IN)	REMARKS
				EAT (°F)	LAT (F)	STEAM PRESSURE (PSI)	FLOW (LBS/HR)				
SC-1	12	18	1600	50	90	2	72.0	0.15	ASV-4	0.75	
SC-2	12	19	1600	50	90	2	72.0	0.15	ASV-8	0.75	
SC-3	20	12	1600	50	90	2	72.0	0.15	ASV-9	0.75	
SC-4	12	24	1800	50	90	2	81.0	0.15	ASV-12	0.75	

EXPANSION TANK SCHEDULE

TAG	MANUFACTURER	MODEL NO.	SERVICE	DIAMETER (IN)	LENGTH (IN)	TANK VOLUME (GAL)	MAX OPERATING WEIGHT (LBS)	REMARKS
ET-1	TACO	CA-90	CHILLED WATER	20	90	23	320	

BUFFER TANK SCHEDULE

TAG No.	MANUFACTURER	MODEL	SERVICE	TANK SIZE (IN)		TANK VOLUME (GAL)	MAX OPERATING WEIGHT (LBS)	REMARKS
				DIAMETER	LENGTH			
BT-1	TACO	BHH0400	CHILLED WATER	48	75	400	5000	

AIR SEPARATOR

TAG	MANUFACTURER	MODEL	SERVICE	PIPE SIZE (IN)	FLOW (GPM)	PRESSURE DROP (FT)	REMARKS
AS-1	TACO	4905AD	CHILLED WATER	5	175	2	

AUTOMATIC CONTROL VALVE - STEAM

TAG	SERVICE	VALVE TYPE	FLOW TYPE	FLOW (LBS/HR)	ENTERING STREAM PRESSURE (PSI)	CV	CLOSE-OFF PRESSURE (PSI)	FAILED POSITION	PIPE SIZE (IN)	REMARKS
ASV-1	BUILDING PREHEAT COILS	GLOBE	2-WAY	1270	10.00	34.2	25.00	CLOSED	4.00	EXISTING STEAM COILS
ASV-2	BUILDING PREHEAT COILS	GLOBE	2-WAY	780	10.00	21	25.00	CLOSED	3.00	EXISTING STEAM COILS
ASV-3	HOT LAB REHEAT COIL	GLOBE	2-WAY	330	10.00	8.9	25.00	CLOSED	2.00	EXISTING 60"x96" STEAM COIL
ASV-4	EAST INSTRUMENT ROOMS	GLOBE	2-WAY	72	10.00	1.9	25.00	CLOSED	1.25	NEW STEAM COIL SC-1
ASV-5	EAST CORRIDOR REHEAT COIL	GLOBE	2-WAY	375	10.00	10.1	25.00	CLOSED	2.00	EXISTING 60"x96" STEAM COIL
ASV-6	CENTER CORRIDOR REHEAT COIL	GLOBE	2-WAY	305	10.00	8.2	25.00	CLOSED	2.00	EXISTING 60"x96" STEAM COIL
ASV-7	WEST CORRIDOR REHEAT COIL	GLOBE	2-WAY	300	10.00	8.1	25.00	CLOSED	2.00	EXISTING 60"x96" STEAM COIL
ASV-8	WEST COMPUTER LAB	GLOBE	2-WAY	72	10.00	1.9	25.00	CLOSED	1.25	NEW STEAM COIL SC-2
ASV-9	WEST INSTRUMENT ROOMS	GLOBE	2-WAY	72	10.00	1.9	25.00	CLOSED	1.25	NEW STEAM COIL SC-3
ASV-10	CHRONIC GAMMA REHEAT COIL	GLOBE	2-WAY	45	10.00	1.2	25.00	CLOSED	1.00	EXISTING 18"x18" STEAM COIL
ASV-11	REACTOR BUILDING SYSTEM REHEAT COIL	GLOBE	2-WAY	275	10.00	7.4	25.00	CLOSED	1.50	EXISTING 84"x96" STEAM COIL
ASV-12	A120	GLOBE	2-WAY	81	10.00	2.2	25.00	CLOSED	1.25	NEW STEAM COIL SC-4
ASV-13	UNIT HEATER	GLOBE	2-WAY	32	10.00	0.9	25.00	CLOSED	1.00	EXISTING UNIT HEATER
ASV-14	UNIT HEATER	GLOBE	2-WAY	17	10.00	0.5	25.00	CLOSED	0.75	EXISTING UNIT HEATER
ASV-15	UNIT HEATER	GLOBE	2-WAY	17	10.00	0.5	25.00	CLOSED	0.75	EXISTING UNIT HEATER
ASV-16	REACTOR ROOM HEATING COIL	GLOBE	2-WAY	520	10.00	14	25.00	CLOSED	2.00	EXISTING HEATING COIL
ASV-17	REACTOR ROOM PRE-HEAT COIL	GLOBE	2-WAY	715	10.00	19.2	25.00	CLOSED	2.50	EXISTING PREHEAT COIL
ASV-18	REACTOR BUILDING 1ST FLOOR	GLOBE	2-WAY	46	10.00	1.2	25.00	CLOSED	1.25	EXISTING 36"x24" STEAM COIL
ASV-19	REACTOR BUILDING 2ND FLOOR	GLOBE	2-WAY	46	10.00	1.2	25.00	CLOSED	1.00	EXISTING 30"x15" STEAM COIL
ASV-20	REACTOR BUILDING D302	GLOBE	2-WAY	40	10.00	1.1	25.00	CLOSED	1.00	EXISTING 18"x15" STEAM COIL
ASV-21	REACTOR BUILDING D300	GLOBE	2-WAY	42	10.00	1.1	25.00	CLOSED	1.00	EXISTING 18"x15" STEAM COIL

AUTOMATIC CONTROL VALVE - WATER

TAG	SERVICE	VALVE TYPE	FLOW TYPE	DESIGN FLOW (GPM)	FLOW COEFF. (Cv)	CLOSE-OFF PRESSURE (PSI)	FAILED POSITION	PIPE SIZE (IN)	REMARKS
AWV-1	RADIATOR	BALL	2-WAY	4.2	2.4	50.00	CLOSED	1.00	
AWV-2	RADIATOR	BALL	2-WAY	4.2	2.4	50.00	CLOSED	1.00	
AWV-3	RADIATOR & CONVECTORS	BALL	2-WAY	3.8	2.2	50.00	CLOSED	1.00	
AWV-4	UNIT HEATER	BALL	3-WAY	2.0	1.2	50.00	CLOSED	0.75	
AWV-5	RADIATORS	BALL	2-WAY	1.8	1	50.00	CLOSED	0.75	
AWV-6	RADIATOR	BALL	2-WAY	3.8	2.2	50.00	CLOSED	1.00	
AWV-7	RADIATORS	BALL	2-WAY	3.0	1.7	50.00	CLOSED	1.00	
AWV-8	CONVECTOR	BALL	2-WAY	0.8	0.5	50.00	CLOSED	0.50	
AWV-9	RADIATORS	BALL	2-WAY	4.5	2.6	50.00	CLOSED	1.00	
AWV-10	RADIATORS	BALL	3-WAY	4.2	2.4	50.00	CLOSED	1.00	
AWV-11	RADIATOR	BALL	2-WAY	1.1	0.6	50.00	CLOSED	0.75	

SUPPLY FAN

TAG	MANUFACTURER	MODEL	TYPE	PERFORMANCE PER FAN				BLADE TYPE	ELECTRICAL PER FAN				REMARKS
				AIRFLOW (CFM)	TSP (IN W.C.)	SPEED (RPM)	POWER (BHP)		VOLTS	PHASE	HP	MOTOR CONTROL (1)(2)	
SF-1	TWINCITY	EPLPN-365M42	PLENUM	16000	2.50	887	7.9	AF-PLENUM	208	3	15	VFD	
SF-2	TWINCITY	EPLPN-365M42	PLENUM	16000	2.50	887	7.9	AF-PLENUM	208	3	15	VFD	

(1) MOTOR CONTROL FURNISHED BY DIV. 23.
(2) MS - MOTOR STARTER, VFD - VARIABLE FREQUENCY DRIVE, ECM - ECM MOTOR CONTROLLER, CR - CONTROL RELAY

EXHAUST FAN

TAG	MANUFACTURER	MODEL	TYPE	PERFORMANCE			MIN EFF. (%)	PERFORMANCE POWER (BHP)	WHEEL			MOTOR			MOTOR CONTROL (1)(2)	REMARKS
				AIRFLOW (CFM)	TSP (IN)	SPEED (RPM)			TYPE	BLADE	DIAMETER (IN)	VOLTS	PHASE	HP		
EF-1	GREENHECK	USF-10-B1	UTILITY	800	3.00	2869	50	0.77	SWSI	BI	10.5	208	3	1	MS	
EF-2	GREENHECK	USF-10-B1	UTILITY	800	3.00	2869	50	0.77	SWSI	BI	10.5	208	3	1	MS	
EF-3	GREENHECK	USF-10-B1	UTILITY	800	3.00	2869	50	0.77	SWSI	BI	10.5	208	3	1	MS	
EF-4	GREENHECK	USF-10-B1	UTILITY	800	3.00	2869	50	0.77	SWSI	BI	10.5	208	3	1	MS	

(1) MOTOR CONTROL FURNISHED BY DIV. 23.
(2) MS - MOTOR STARTER, VFD - VARIABLE FREQUENCY DRIVE, ECM - ECM MOTOR CONTROLLER, CR - CONTROL RELAY

HVAC DESIGN CRITERIA

GENERAL	HEATING		COOLING			
PROJECT SITE	SITE ELEVATION	DESIGN AMBIENT (°F)	SPACE TEMPERATURE (°F)	DESIGN AMBIENT DRY BULB (°F)	DESIGN AMBIENT WET BULB (°F)	SPACE TEMPERATURE (°F)	REMARKS
CORVALLIS, OR	235	17	70	95	68	80	

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JAN. 11, 2005
PAUL E. FOLKS
RENEWS: 12-31-19

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

SCHEDULES

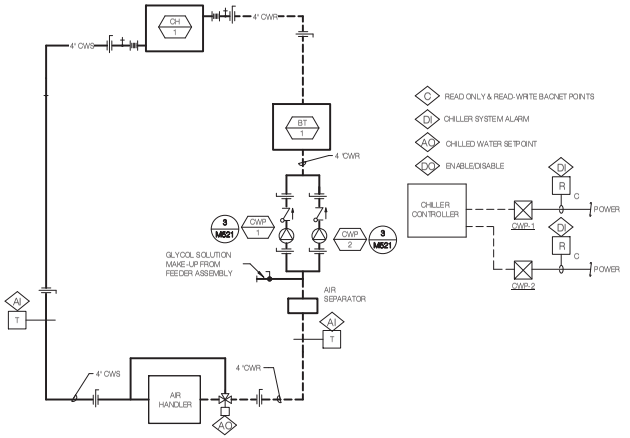
MARK	DATE	DESCRIPTION

DESIGNED: PEF
DRAWN: TKO
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

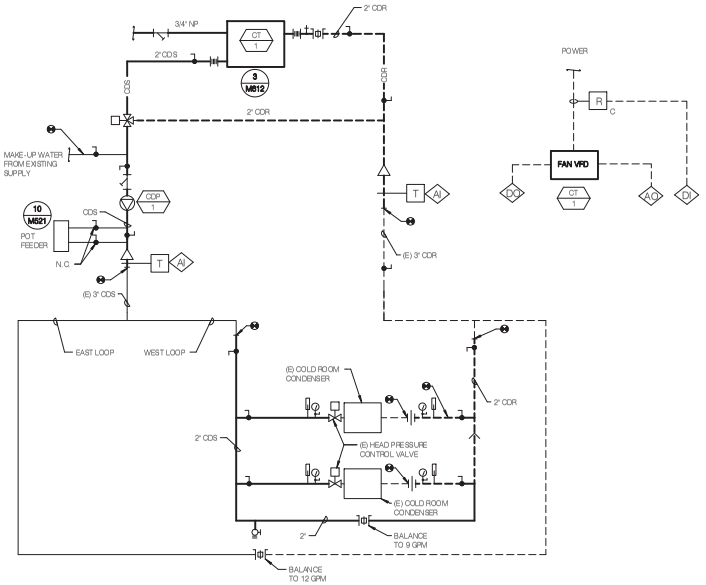
M601

PLOTTED BY: TKO ON: 11/14/2019 4:57:09 PM



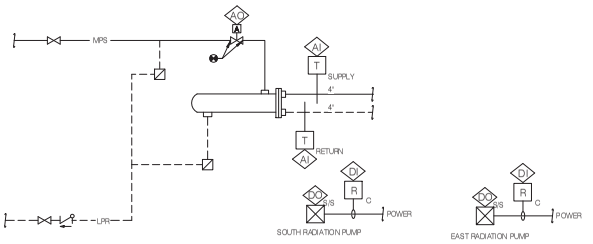
1 CHILLED WATER SCHEMATIC

NOT TO SCALE



2 CONDENSER WATER SCHEMATIC

NOT TO SCALE



3 HEATING WATER SYSTEM

NOT TO SCALE

SYSTEMS WEST ENGINEERS
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541.342.7210
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REGISTERED PROFESSIONAL ENGINEER
DIGITALLY SIGNED
OREGON
JAN. 31, 2003
PAUL E. FOUKS
RENEWS: 6-30-20

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

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Oregon State University

DIAGRAMS

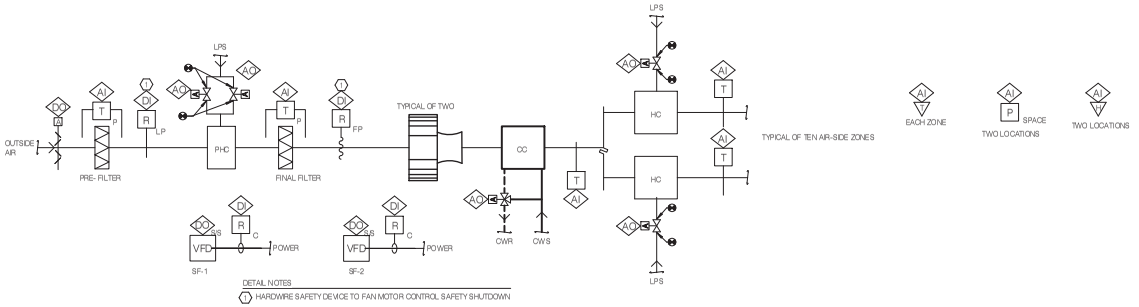
MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: JSH
CHECKED: PEF

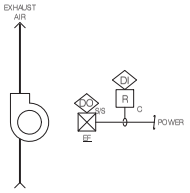
DATE: 11/13/2019
PROJECT: T049.11

M611

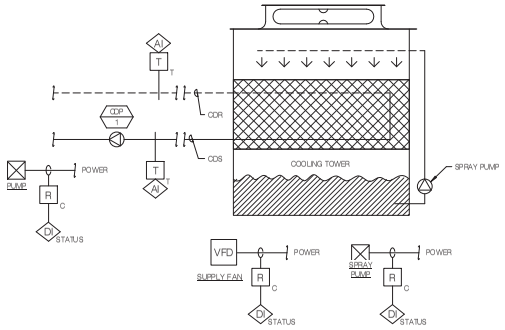
PLOTTED BY: JSH ON: 11/15/2019 8:40:56 AM



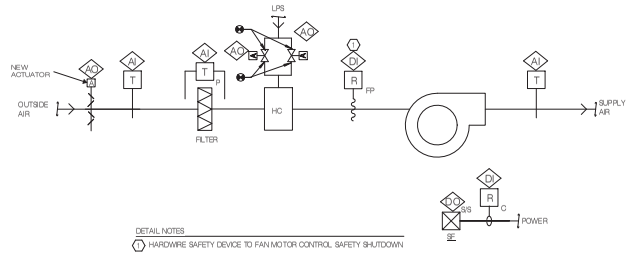
1 **RADIATION CENTER ASU-1**
NOT TO SCALE



2 **EXHAUST FAN**
NOT TO SCALE



3 **COOLING TOWER**
NOT TO SCALE



4 **REACTOR BUILDING ASU-1**
NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER
DIGITALLY SIGNED
OREGON
JAN. 31, 2006
PAUL E. FOOKS

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

DIAGRAMS

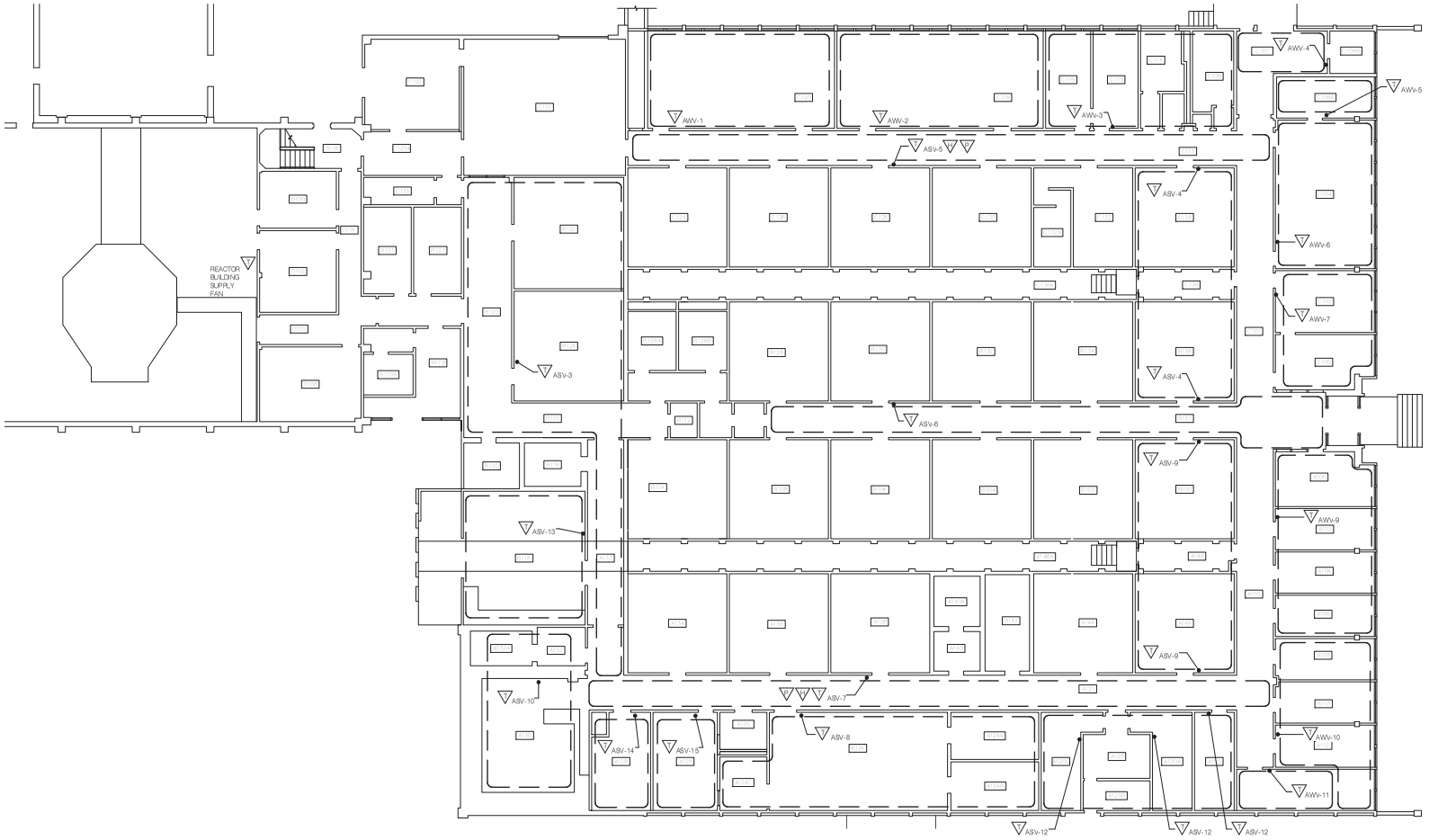
MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: JSH
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

M612

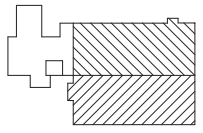
PLOTTED BY: JSH ON: 11/14/2019 4:57:11 PM



NORTH

1 ZONE MAP

3/32" = 1'-0"



NORTH KEY PLAN

NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER
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OREGON
JAN. 11, 2005
PAUL E. FOUKS
RENEWAL: 6/30/20

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

ZONE MAP

MARK	DATE	DESCRIPTION

DESIGNED: TKO
DRAWN: JSH
CHECKED: PEF

DATE: 11/13/2019
PROJECT: T049.11

M701

PLOTTED BY: JSH ON: 11/14/2019 4:57:12 PM

ELECTRICAL LEGEND

LOW-VOLTAGE ELECTRICAL CONDUCTORS & CABLES

- NEW CONCEALED RACEWAY AND WIRE. NUMBER OF SLASHES INDICATES NUMBER OF CONDUCTORS IF MORE THAN TWO. SIZE OTHER THAN #12 AS NOTED. (APPLIES TO ALL WIRING SYMBOLS)
- UNDERGROUND OR UNDERFLOOR RACEWAY
- HOMERUN
- OHD OVERHEAD POWER LINE
- SPLICE

GROUNDING & BONDING FOR ELECTRICAL SYSTEMS

- GROUND

RACEWAYS & BOXES FOR ELECTRICAL SYSTEMS

- CONDUIT UP
- CONDUIT DOWN
- FLEXIBLE CONNECTION
- JUNCTION BOX
- STUB

LOW-VOLTAGE DISTRIBUTION

- TRANSFORMER
- CURRENT TRANSFORMER
- ELECTRICAL EQUIPMENT AS INDICATED ON DRAWINGS

PANELBOARDS

- LV -1 / 208 / 225 / 3 — PANELBOARD - VOLTAGE AND SIZE AS NOTED
- SURFACE BRANCH PANELBOARD (120/208V)
- SURFACE BRANCH PANELBOARD (277/480V)
- RECESSED BRANCH PANELBOARD (120/208V)
- RECESSED BRANCH PANELBOARD (277/480V)

ELECTRICAL CABINETS & ENCLOSURES

- CABINET, SURFACE MOUNTED. TYPE AS NOTED.
- ELECTRICAL EQUIPMENT AS INDICATED ON DRAWINGS

WIRING DEVICES

- TS — WALL SWITCH. "a" = CIRCUITS CONTROLLED, "K" = KEY SWITCH, "P" = W/PILOT LIGHT, "2" = DOUBLE POLE, "3" = THREE-WAY, "M" = AUTOMATIC WALL SWITCH, "D" = DIMMING SWITCH, "TS" = DIGITAL TIMER SWITCH
- L6-30 — SPECIAL RECEPTACLE, NEMA CONFIGURATION INDICATED
- WP GFI — DUPLEX RECEPTACLE. WP = WEATHERPROOF, "GFI" = GROUND FAULT CIRCUIT INTERRUPTER TYPE, "AV" = DEDICATED AUDIO VISUAL EQUIPMENT RECEPTACLE
- +44" 8 — DUPLEX RECEPTACLE MOUNTED ABOVE STANDARD HEIGHT. HEIGHT INDICATED IN INCHES. WHERE NO HEIGHT INDICATED, MOUNT ABOVE COUNTERTOP.
- QUAD RECEPTACLE
- EQUIPMENT CONNECTION

OVER-CURRENT PROTECTIVE DEVICES

- FUSE
- CIRCUIT BREAKER
- G — GROUND FAULT INTERRUPT CIRCUIT BREAKER
- SWITCH
- FUSED SWITCH

MOTOR & CIRCUIT DISCONNECTS

- COMBINATION DISCONNECT AND MAGNETIC STARTER
- DISCONNECT SWITCH
- FUSED DISCONNECT SWITCH
- MAGNETIC STARTER
- MANUAL MOTOR STARTER WITH THERMAL OVERLOAD PROTECTION & LOCKABLE OFF COVER
- M — MOTOR CONNECTION

LIGHTING FIXTURES

- A1 — FIXTURE IDENTIFIER. FIXTURE TYPE "A1" SEE LUMINAIRE SCHEDULE.
- LINEAR SURFACE LUMINAIRE
- SUSPENDED LUMINAIRE IN 4', 8' & 12' LENGTHS, MOUNTED END-TO-END WHERE SHOWN

FIRE DETECTION & ALARM

- S — FIRE ALARM SYSTEM HORN. S = SPEAKER, WP = WEATHERPROOF
- FIRE ALARM STROBE
- FIRE ALARM SYSTEM HORN/STROBE LIGHT - MOUNT @ 84" A.F.F.
- D — FIRE ALARM SYSTEM SMOKE DETECTOR. D = DUCT DETECTOR, R = RELAY BASE
- FIRE/SMOKE DAMPER

GENERAL

- EF 1 — EQUIPMENT IDENTIFIER (EXHAUST FAN 1 SHOWN)
- 1 — SHEET REFERENCE NOTE
- 2 / E-121 — PLAN OR DETAIL NUMBER / SHEET NUMBER (2 / E-501)
- EXISTING WORK SHOWN LIGHT
- NEW WORK SHOWN BOLD
- EXISTING TO BE REMOVED

GENERAL NOTES

1. THE FACILITY WILL REMAIN IN OPERATION DURING CONSTRUCTION.
2. COORDINATE ALL SHUTDOWNS AND CONSTRUCTION ACTIVITY WITH FACILITIES STAFF.
3. SIZE AND LOCATION OF ALL EXISTING ELECTRICAL EQUIPMENT IS APPROXIMATE. CONTRACTOR SHALL SITE VERIFY THE EXACT LOCATION OF EXISTING AND CONSTRUCT ALL WORK FROM FIELD DIMENSIONS.
4. CONTRACTOR SHALL MAKE ADJUSTMENTS NECESSARY TO ACCOMMODATE MINOR DEVIATIONS AT NO COST TO OWNER.
5. LIGHT LINE WORK INDICATES EXISTING ELECTRICAL CIRCUITRY AND OTHER ELECTRICAL EQUIPMENT. DASHED LINE WORK INDICATES ELECTRICAL DEVICES AND EQUIPMENT TO BE REMOVED.
6. WHERE EXISTING EQUIPMENT IS REMOVED AND NOT REPLACED IN THE SAME LOCATION, PATCH AND PAINT SURFACES TO MATCH ORIGINAL CONDITION.
7. REMOVE ALL ABANDONED RACEWAY AND WIRING.
8. RECONNECT ALL CIRCUITRY TO REMAINING DEVICES AND EQUIPMENT.
9. MAINTAIN ACCESSIBILITY OF EQUIPMENT AND JUNCTION BOXES AS NECESSARY AND TO OWNER'S SATISFACTION.
10. RUN ALL BUILDING RACEWAY CONCEALED, UNLESS OTHERWISE NOTED.
11. CARRY GROUND WIRE IN ALL LIGHTING, POWER, AND FEEDER CIRCUITS.
12. COORDINATE ALL DEVICE LOCATIONS WITH OTHER TRADES TO AVOID POSSIBLE CONFLICTS WITH DUCTS, SPRINKLER PIPING AND OTHER OBSTACLES AFFECTING INSTALLATION.
13. PROVIDE BLANK FACE PLATES FOR ALL SWITCHES BEING REMOVED.
14. THE WORD 'PROVIDE' WHEN USED ON THESE ELECTRICAL PLANS IS INTENDED TO MEAN THAT THE ELECTRICAL CONTRACTOR IS TO FURNISH AND INSTALL THE RELATED WORK DESCRIBED UNLESS OTHERWISE NOTED.
15. THE TERM "WIRING" AS USED ON THE DRAWINGS INCLUDES BOTH THE RACEWAY AND CONDUCTORS WITHIN.
16. ALL DEMOLISHED EQUIPMENT SHALL BE SALVAGED TO OWNER.

ABBREVIATIONS

AFF	ABOVE FINISHED FLOOR	IDF	INTERMEDIATE DISTRIBUTION FRAME
BLDG	BUILDING	LV	LOW VOLTAGE
C	CONDUIT	MDF	MAIN DISTRIBUTION FRAME
cd	CANDELA	MECH	MECHANICAL
CKT	CIRCUIT	MW	MICROWAVE
DIM	0-10V DIMMING	(N)	NEW
DSP	DIGITAL SIGNAL PROCESSOR	(NL)	NEW LOCATION
(E)	EXISTING	PNL	PANEL
ELEC	ELECTRICAL	(RL)	RELOCATE
EMERG	EMERGENCY	SWBD	SWITCHBOARD
FAM	FIRE ALARM MASTER	TTB	TELEPHONE TERMINAL BOARD
GD	GARBAGE DISPOSAL	TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSION
GFI	GROUND FAULT INTERRUPTER		
GND	GROUND	TYP	TYPICAL
HVAC	HEATING, VENTILATING & AIR CONDITIONING	WG	WIREGUARD
		WP	WEATHERPROOF

ELECTRICAL LOAD SUMMARY

OSU RADIATION CENTER

EXISTING PEAK 12 MONTH DEMAND:		225	KVA
HIGH DEMAND @ CODE 125%		281.3	KVA
REMOVED LOAD, THIS PHASE:		75.6	KVA
CALCULATED LOAD (208/120)			
MOTOR LOADS		55.1	KVA
MISC. LOADS		182.6	KVA
	Total	237.6	KVA
TOTAL CONNECTED LOAD		**443.3**	**KVA**
SYSTEM ANTICIPATED AMPERES @ SERVICE VOLTAGE 208/120 3 PH		**1230**	**AMPS**

SHEET INDEX - ELECTRICAL

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REGISTERED PROFESSIONAL ENGINEER — OREGON — DIGITALLY SIGNED — MAY 21, 2019 — MATTHEW B. REICH

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

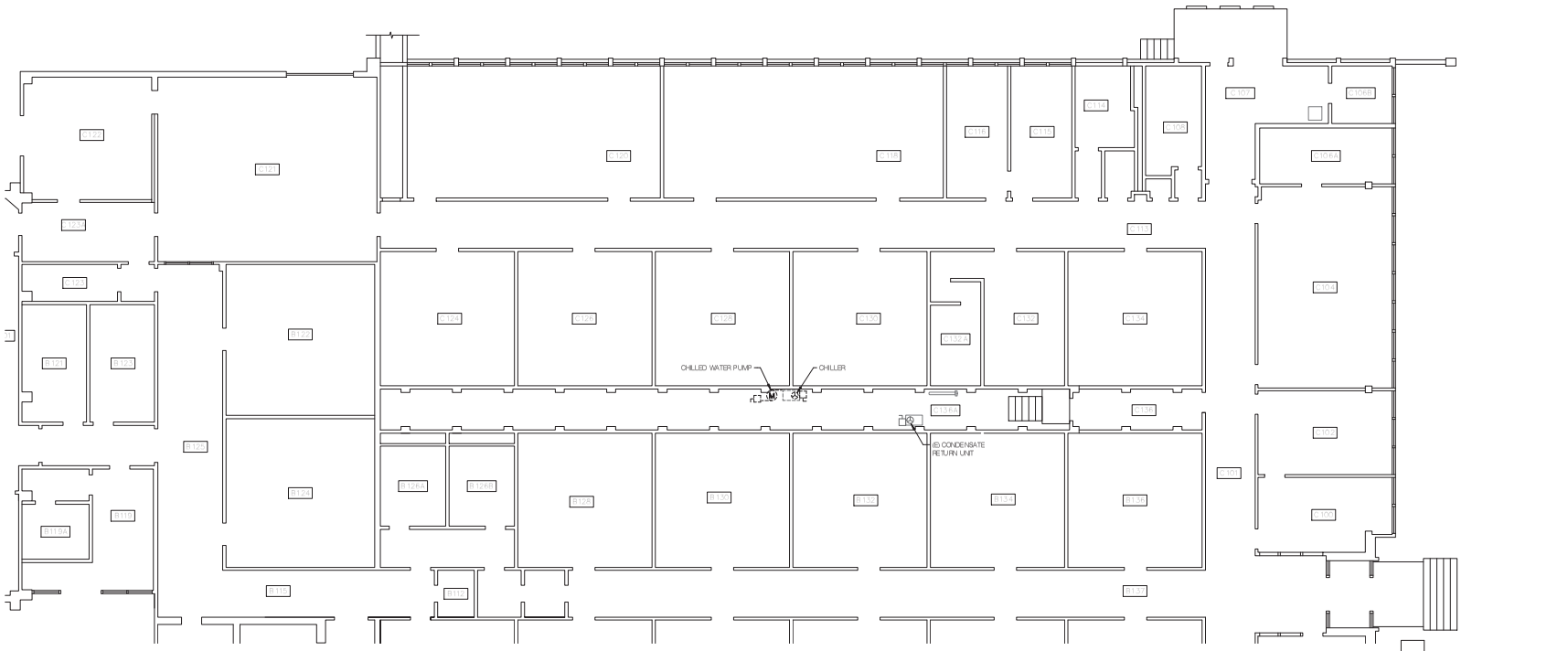
LEGEND, GENERAL NOTES & SHEET INDEX

MARK	DATE	DESCRIPTION

DESIGNED:	CCS
DRAWN:	CCS
CHECKED:	MBR
DATE:	11/13/2019
PROJECT:	T049.11

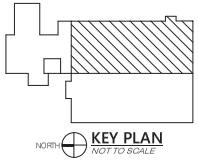
E001

PLOTTED BY: CCS ON: 11/14/2019 5:05:21 PM



NORTH

1 DEMOLITION PLAN - LOWER LEVEL EAST
1/8" = 1'-0"



NORTH KEY PLAN
NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER
OREGON
DIGITALLY SIGNED
MAY 21, 2014
MATTHEW B. RITCH

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

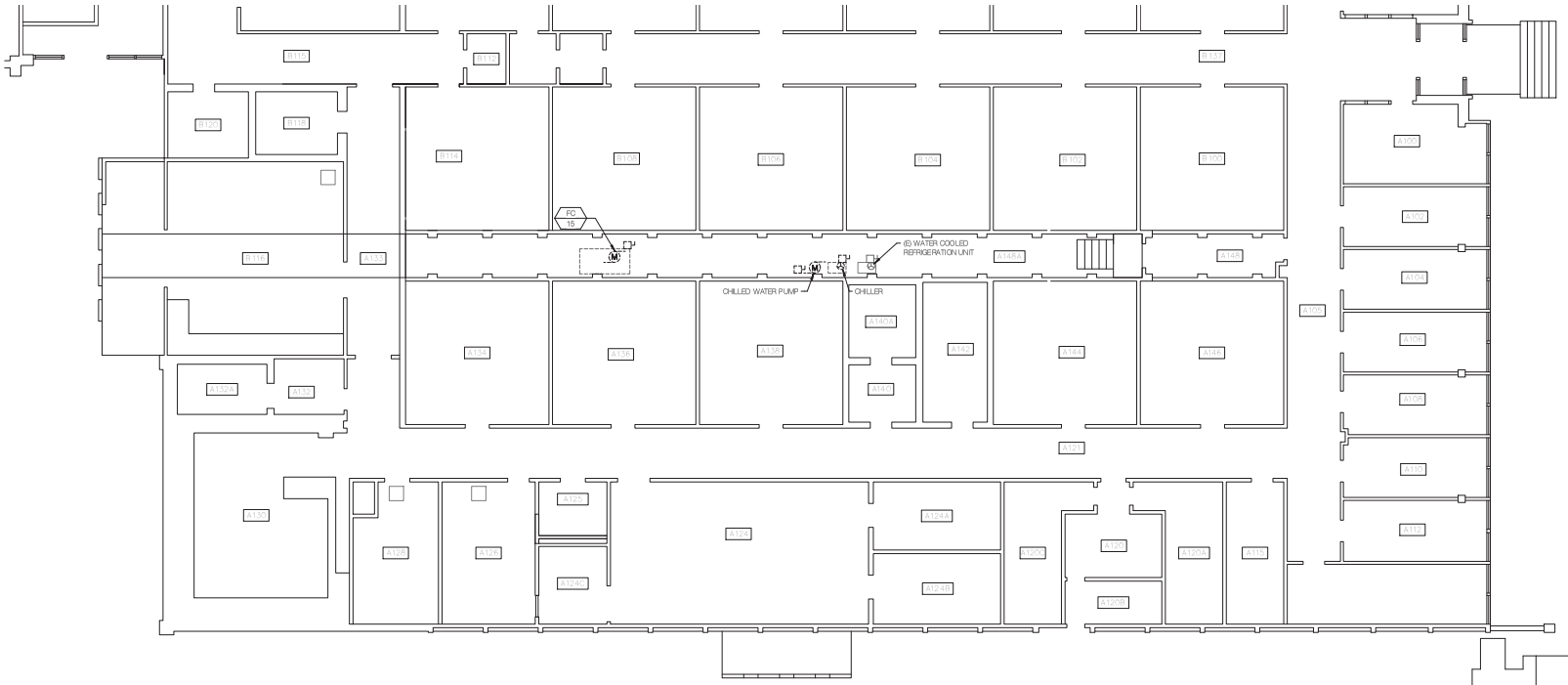
DEMOLITION PLAN - LOWER LEVEL EAST

MARK	DATE	DESCRIPTION

DESIGNED:	CCS
DRAWN:	CCS
CHECKED:	MBR
DATE:	11/13/2019
PROJECT:	T049.11

E101

PLOTTED BY: CCS ON: 11/14/2019 5:05:21 PM



NORTH

1 DEMOLITION PLAN - LOWER LEVEL WEST

1/8" = 1'-0"

NORTH KEY PLAN
NOT TO SCALE

SYSTEMS WEST ENGINEERS
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REGISTERED PROFESSIONAL ENGINEER
OREGON
JULY 27, 2007
MATTHEW B. RITCH

DIGITALLY SIGNED
OREGON
MAY 21, 2014
RENEWAL: 12/31/19

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

DEMOLITION PLAN - LOWER LEVEL WEST

MARK	DATE	DESCRIPTION

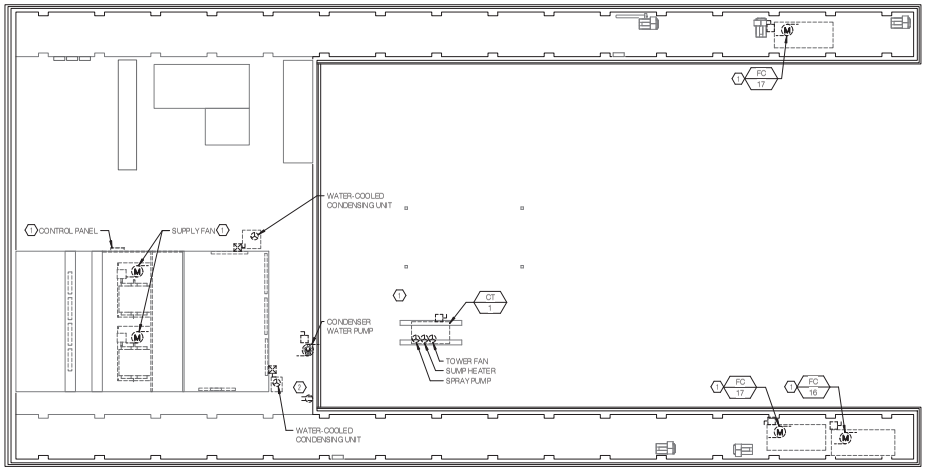
DESIGNED:	CCS
DRAWN:	CCS
CHECKED:	MBR
DATE:	11/13/2019
PROJECT:	T049.11

E102

PLOTTED BY: CCS ON: 11/14/2019 5:05:22 PM

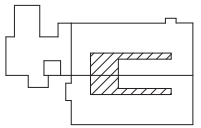
REFERENCE NOTES

1. DISCONNECT EQUIPMENT. CIRCUIT SHALL BE RETAINED FOR RECONNECTION TO NEW EQUIPMENT IN SAME LOCATION. COORDINATE WITH MECHANICAL.
2. REMOVE EXISTING RECEPTACLE SERVING HEAT TRACE. RETAIN CIRCUIT FOR RECONNECTION TO NEW HEAT TRACE SYSTEM IN SAME LOCATION. COORDINATE WITH MECHANICAL.



NORTH

1 DEMOLITION PLAN - UPPER LEVEL & ROOF
1/8" = 1'-0"



NORTH KEY PLAN
NOT TO SCALE

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REGISTERED PROFESSIONAL ENGINEER
OREGON
DIGITALLY SIGNED
MAY 21, 2004
MATTHEW B. RITCH

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

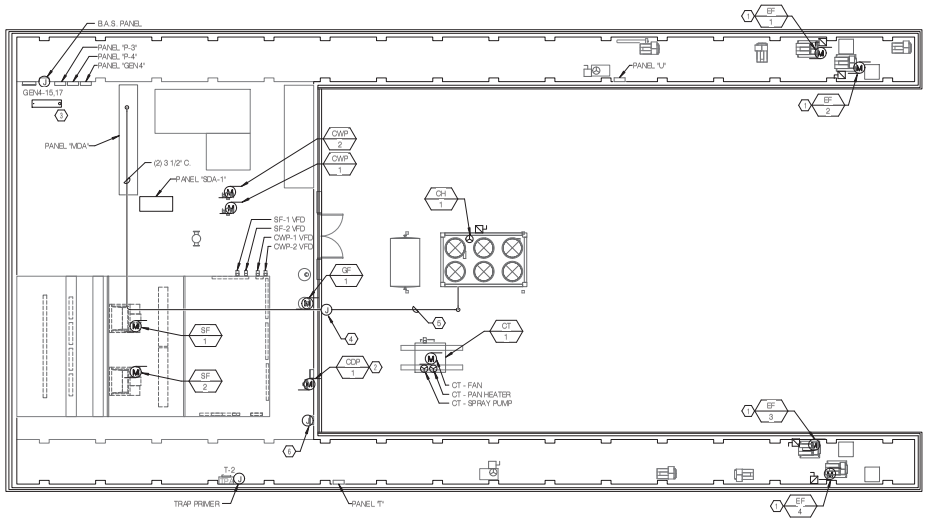
DEMOLITION PLAN - UPPER LEVEL & ROOF

MARK	DATE	DESCRIPTION

DESIGNED:	COS
DRAWN:	COS
CHECKED:	MBR
DATE:	11/13/2019
PROJECT:	T049.11

E103

PLOTTED BY: CCS ON: 11/14/2019 5:05:23 PM



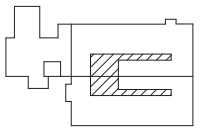
NORTH

1 **POWER DISTRIBUTION PLAN - UPPER LEVEL & ROOF**

1/8" = 1'-0"

REFERENCE NOTES:

1. INTERCEPT AND EXTEND EXISTING CIRCUIT PREVIOUSLY SERVING FAN UNIT TO SERVE NEW EXHAUST FAN. COORDINATE CONNECTION WITH MECHANICAL.
2. UTILIZE EXISTING CIRCUIT MADE AVAILABLE DURING DEMOLITION TO SERVE NEW CONDENSER/WATER PUMP IN SAME LOCATION. COORDINATE CONNECTION WITH MECHANICAL.
3. PROVIDE CHAIN-HUNG LINEAR LED STRIP LIGHT. CIRCUIT LIGHT FIXTURE TO EXISTING LIGHTING CIRCUIT IN SPACE. BASIS OF DESIGN: LITHONIA CLX L48 SEF RDL WD 120V 40K 80CRI
4. PROVIDE JUNCTION BOX FOR VERTICAL TRANSITION OF CHILLER FEEDER. SIZE JUNCTION BOX PER NEC.
5. FEEDER SERVING CHILLER SHALL BE ROUTED WITH CHILLED WATER PIPING AND UTILIZE SAME ROOF SUPPORT STRUCTURE. COORDINATE INSTALLATION WITH MECHANICAL.
6. UTILIZE EXISTING CIRCUIT, MADE AVAILABLE DURING DEMOLITION, TO SERVE NEW HEAT TRACE SYSTEM (HT-1). COORDINATE CONNECTION WITH MECHANICAL.



NORTH KEY PLAN
NOT TO SCALE

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735 A Street
Springfield, OR 97477
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REGISTERED PROFESSIONAL ENGINEER
DIGITALLY SIGNED
OREGON
MAY 21, 2014
MATTHEW B. REICH

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

POWER DISTRIBUTION PLAN - UPPER LEVEL & ROOF

MARK	DATE	DESCRIPTION

DESIGNED: COS
DRAWN: COS
CHECKED: MBR

DATE: 11/13/2019
PROJECT: T049.11

E121

PLOTTED BY: CCS ON: 11/14/2019 5:05:24 PM

PANEL SCHEDULE

PANEL: P-3
VOLTS: 120/208
LOCATION: ELECTRICAL MEZZ.
MOUNTING: SURFACE
TYPE: BOLT ON **AMPS:** 225
PHASE: 3 **WIRE:** 4
MAIN: MLO

NOTES: EXISTING 42 CIRCUIT PANEL
(N) INDICATES A NEW BREAKER SERVING NEW LOAD.
(E) INDICATES AN EXISTING BREAKER SERVING AN EXISTING LOAD.
(EN) INDICATES AN EXISTING BREAKER SERVING A NEW LOAD
(RP) INDICATES REPLACE AN EXISTING BREAKER WITH BREAKER SIZE SHOWN, BREAKER SHALL MATCH EXISTING PANEL MANUFACTURER.

LOAD CLASS	Conn. VA	Demand Factor	Demand Load VA
LIGHTING	0	1.25%	0
OUTLETS	0	*	0
MOTOR LOADS	4266	**	5,598
RESISTANCE LOADS	0	100%	0
SUBFEED	0	100%	0
MISC. LOADS	6261	100%	6,261
SUBFEED BREAKER	0		0
		Connected	Demand
TOTAL VOLT-AMPS		10,817	11,859
MAXIMUM PHASE AMPS		36.7	42.1

BREAKER A	BREAKER P	DESCRIPTION	WATTS	CIR. NO.	PHASE	CIR. NO.	WATTS	DESCRIPTION	BREAKER P	BREAKER A
20	1	(E) LTG: MECH ROOM		1	A	10		(E) RECEPT.: MECH ROOM	1	20
20	1	(E) LTG: FAN ROOM		2	B	11		(E) CIRC PUMP WATER HEATER	1	20
20	1	(E) LTG: MECH ROOM		3	C	12		OFF???	1	20
20	1	(E) FAN #20		4	A	13		(E) CHEM PUMP COOLING TOWER	1	20
20	1	(E) FAN AGN ROOM (C121 EX. FAN) - OFF		5	B	14		(E) HEAT TAPE SOUTH COOLING TOWER	1	20
20	1	(RP) GF-1	1656	6	C	15		(E) HEAT TAPE SOUTH COOLING TOWER	1	20
50	2	(E) SPARE		7	A	16		(E) FAN #14	1	20
				8	B	17		(E) FAN #15	1	20
20	1	(E) RO		9	C	18		(E) FAN #15	1	20
20	3	(E) FAN #1 9 (B1 22)		19	A	20		(E) FAN #21 (C-1 24)	3	30
					B					
					C					
20	3	(E) FAN #1 8 (B1 24)		21	A	22	2087	(RP) COOLING TOWER	3	30
					B		2087			
					C		2087			
20	3	(E) FAN #1 3 (A1 34)		23	A	24	900	(RP) CDP-1	3	15
					B		900	2HP		
					C		900			
20	3	(E) FAN #1 3 (A1 34)		25	A	26		(E) SPARE	3	20
					B					
					C					

		A	B	C
PHASE TOTALS	Connected VA	2987	2987	4643
	Demand VA	3401	3401	5057
	Connected Amps	24.9	24.9	38.7
	Demand Amps	28.3	28.3	42.1

* 10kVA at 100%, remainder at 50%
** 100% plus 25% of the largest Motor

PANEL SCHEDULE

PANEL: P-4
VOLTS: 120/208
LOCATION: ELECTRICAL MEZZ.
MOUNTING: SURFACE
TYPE: BOLT ON **AMPS:** 225
PHASE: 3 **WIRE:** 4
MAIN: MLO

NOTES: EXISTING 54 CIRCUIT PANEL

LOAD CLASS	Conn. VA	Demand Factor	Demand Load VA
LIGHTING	0	1.25%	0
OUTLETS	0	*	0
MOTOR LOADS	0	**	0
RESISTANCE LOADS	0	100%	0
SUBFEED	0	100%	0
MISC. LOADS	0	100%	0
SUBFEED BREAKER	0		0
		Connected	Demand
TOTAL VOLT-AMPS		0	0
MAXIMUM PHASE AMPS		0.0	0.0

BREAKER A	BREAKER P	DESCRIPTION	WATTS	CIR. NO.	PHASE	CIR. NO.	WATTS	DESCRIPTION	BREAKER P	BREAKER A
20	3	(E) FAN #17 (B1 22)		1	A	2		(E) FAN #23 (C-1 24)	3	30
					B					
					C					
20	3	(E) FAN #16 (B1 24)		3	A	4		(E) FAN #22 (C-1 20)	3	20
					B					
					C					
20	3	?LOAD UNKNOWN?		5	A	6		(E) FAN #10	3	20
					B					
					C					
20	3	(E) FAN #9 (A-136)		7	A	8		OFF	3	20
					B					
					C					
20	3	(E) FAN #8 (B-108)		9	A	10		(E) SPARE???	1	20
					B			(E) WATER HEATER B & C	2	30
					C					
20	3	(E) FAN #11 (A-126)		11	A	12		?LOAD UNKNOWN?	3	20
					B					
					C					
20	3	(E) FAN #12 (B1 14)		13	A	14		(E) SPACE		
					B			(E) WATER HEATER	2	30
					C					
30	3	?LOAD UNKNOWN?		15	A	16		?LOAD UNKNOWN?	3	20
					B					
					C					
70	3	?LOAD UNKNOWN?		17	A	18		(E) SPACE		
					B	19		(E) SPACE		
					C	20		(E) SPACE		
				55	A	56				
				57	B	58				
20	1			59	C	60				

		A	B	C
PHASE TOTALS	Connected VA	0	0	0
	Demand VA	0	0	0
	Connected Amps	0.0	0.0	0.0
	Demand Amps	0.0	0.0	0.0

* 10kVA at 100%, remainder at 50%
** 100% plus 25% of the largest Motor

PANEL SCHEDULE

PANEL: T
VOLTS: 120/208
LOCATION: WEST UTILITY TUNNEL
MOUNTING: SURFACE
TYPE: BOLT ON **AMPS:** 225
PHASE: 3 **WIRE:** 4
MAIN: MLO

NOTES: EXISTING 30 CIRCUIT PANEL
(N) INDICATES A NEW BREAKER SERVING NEW LOAD.
(E) INDICATES AN EXISTING BREAKER SERVING AN EXISTING LOAD.
(EN) INDICATES AN EXISTING BREAKER SERVING A NEW LOAD
(RP) INDICATES REPLACE AN EXISTING BREAKER WITH BREAKER SIZE SHOWN OR SPACE, BREAKER SHALL MATCH EXISTING PANEL MANUFACTURER.

LOAD CLASS	Conn. VA	Demand Factor	Demand Load VA
LIGHTING	0	1.25%	0
OUTLETS	0	*	0
MOTOR LOADS	0	**	0
RESISTANCE LOADS	0	100%	0
SUBFEED	0	100%	0
MISC. LOADS	100	100%	100
SUBFEED BREAKER	0		0
		Connected	Demand
TOTAL VOLT-AMPS		100	100
MAXIMUM PHASE AMPS		0.8	0.8

BREAKER A	BREAKER P	DESCRIPTION	WATTS	CIR. NO.	PHASE	CIR. NO.	WATTS	DESCRIPTION	BREAKER P	BREAKER A
20	1	(E) LTG: TUNNEL		1	A	6		(E) SPARE	1	20
20	1	(EN) TRAP PRIMER	100	2	B	7		(E) SPARE	1	20
40	3	(E) AIR COND.		3	C	8		(E) SPARE	1	20
				4	A	8		(E) WELDING RECEPT	2	30
				5	B	10				
20	3	(E) REFRIGERATOR COND. 1		11	C	12		(E) REFRIGERATOR COND. 2	3	20
					A					
					B					
20	3	(E) REFRIGERATOR COND. 3		13	C	14		(E) SPARE	3	40
					A					
					B					
20	3	(E) III 3 LOWER		15	C	16		(E) PUMP UNIT 1	3	60
					A					
					B					
		(E) SPACE		17	C	18		(E) SPACE		
				31	A	32				
				33	B	34				
				35	C	36				
				37	B	38				
				39	C	40				
				41	B	42				

		A	B	C
PHASE TOTALS	Connected VA	0	100	0
	Demand VA	0	100	0
	Connected Amps	0.0	0.8	0.0
	Demand Amps	0.0	0.8	0.0

* 10kVA at 100%, remainder at 50%
** 100% plus 25% of the largest Motor

PANEL SCHEDULE

PANEL: U
VOLTS: 120/208
LOCATION: EAST UTILITY TUNNEL
MOUNTING: SURFACE
TYPE: BOLT ON **AMPS:** 225
PHASE: 3 **WIRE:** 4
MAIN: MLO

NOTES: EXISTING 30 CIRCUIT PANEL
(N) INDICATES A NEW BREAKER SERVING NEW LOAD.
(E) INDICATES AN EXISTING BREAKER SERVING AN EXISTING LOAD.
(EN) INDICATES AN EXISTING BREAKER SERVING A NEW LOAD
(RP) INDICATES REPLACE AN EXISTING BREAKER WITH BREAKER SIZE SHOWN, BREAKER SHALL MATCH EXISTING PANEL MANUFACTURER.

LOAD CLASS	Conn. VA	Demand Factor	Demand Load VA
LIGHTING	0	1.25%	0
OUTLETS	0	*	0
MOTOR LOADS	0	**	0
RESISTANCE LOADS	0	100%	0
SUBFEED	0	100%	0
MISC. LOADS	0	100%	0
SUBFEED BREAKER	0		0
		Connected	Demand
TOTAL VOLT-AMPS		0	0
MAXIMUM PHASE AMPS		0.0	0.0

BREAKER A	BREAKER P	DESCRIPTION	WATTS	CIR. NO.	PHASE	CIR. NO.	WATTS	DESCRIPTION	BREAKER P	BREAKER A
20	1	(E) TUNNEL SUMP PUMP		1	A	5		(E) LTG: TUNNEL	1	20
20	1	(E) SOLVENT STORAGE FAN		2	B	6		XEROX MACHINE (NO BREAKER)		
20	1	(E) HEATER UNIT ROOM C-1 06		3	C	7		(E) CIRC PUMP 1 - NORTH	1	20
20	1	(E) DRINKING FOUNTAIN EAST CORR.		4	A	8		(E) CIRC PUMP 2 - SOUTH	1	20
20	2	(E) STILL (B-136)		9	B	10		(E) CONDENSATION PUMP - SOUTH	3	20
					C					
20	1	(E) DRYER (B-136)			A					
40	3	(E) 7.1-2HP CHILLER		11	B	12		(E) CONDENSATION PUMP - NORTH	3	20
					C					
					A					
20	2	(E) 15AMP TWIST LOCK (B-132)		13	B	14		(E) 30AMP TWIST LOCK (B-132)	2	30
					C					
20	1	??LOAD UNKNOWN??			A			??LOAD UNKNOWN??	1	20
50	2	(E) WELDING RECEPT		15	B	17		(E) CONTROL BY DOOR	1	20
				16	C	18		SPACE		
				31	A	32				
				33	B	34				
				35	C	36				
				37	A	38				
				39	B	40				
				41	C	42				

		A	B	C
PHASE TOTALS	Connected VA	0	0	0
	Demand VA	0	0	0
	Connected Amps	0.0	0.0	0.0
	Demand Amps	0.0	0.0	0.0

* 10kVA at 100%, remainder at 50%
** 100% plus 25% of the largest Motor

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REGISTERED PROFESSIONAL ENGINEER
OREGON
DIGITALLY SIGNED
MAY 21, 2014
MATTHEW B. REICH

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

SCHEDULES

MARK	DATE	DESCRIPTION

DESIGNED: COS
DRAWN: CCS
CHECKED: MBR

DATE: 11/13/2019
PROJECT: T049.11

E601

PANEL SCHEDULE

PANEL: GEN 4

VOLTS: 120/208

LOCATION: ELECTRICAL ROOM

MOUNTING: SURFACE

TYPE: BOLT ON **AMPS:** 100

PHASE: 3 **WIRE:** 4

MAIN: MLO

NOTES: EXISTING 30 CIRCUIT PANEL
(N) INDICATES A NEW BREAKER SERVING NEW LOAD.
(E) INDICATES AN EXISTING BREAKER SERVING AN EXISTING LOAD.
(E/N) INDICATES AN EXISTING BREAKER SERVING A NEW LOAD.
(RP) INDICATES REPLACE AN EXISTING BREAKER WITH BREAKER SIZE SHOWN OR SPACE. BREAKER SHALL MATCH EXISTING PANEL MANUFACTURER.

LOAD CLASS	Conn. VA	Demand Factor	Demand Load VA
LIGHTING	0	125%	0
OUTLETS	0	*	0
MOTOR LOADS	0	**	0
RESISTANCE LOADS	0	100%	0
SUBFEED	0	100%	0
MISC. LOADS	1200	100%	1200
SUBFEED BREAKER	0		0
	Connected		Demand
TOTAL VOLT-AMPS	1,200		1,200
MAXIMUM PHASE AMPS	5.0		5.0

BREAKER A	BREAKER P	DESCRIPTION	WATTS	CIR. NO.	PHASE	CIR. NO.	WATTS	DESCRIPTION	BREAKER P	BREAKER A
		(E) SPACE		1	A	2		(E) SPACE		
		(E) SPACE		3	B	4		(E) SPACE		
		(E) SPACE		5	C	6		(E) SPACE		
		(E) SPACE		7	A	8		(E) SPACE		
		(E) SPACE		9	B	10		(E) SPACE		
		(E) SPACE		11	C	12		(E) SPACE		
		(E) SPACE		13	A	14		(E) RC EXTERIOR LIGHTS	3	20
20	1	(N) BAS PANEL	600	15	B	16				
20	1	(N) BAS PANEL	600	17	C	18				
20	1	(E) WEST TUNNEL DATA RACK		19	A	20		(E) CONTROL AIR COMPRESSOR	3	20
30	1	(E) ROOM B100 UPS 30A RECEPT		21	B	22				
		(E) SPACE		23	C	24				
20	1	(E) EAST TUNNEL SUMP PUMP		25	A	26		(E) PANEL "E1"	3	40
30	1	(E) ROOM B136 UPS 30A RECEPT		27	B	28				
20	1	(E) EAST TUNNEL DATA RACK		29	C	30				
				31	A	32				
				33	B	34				
				35	C	36				
				37	A	38				
				39	B	40				
				41	C	42				

PHASE TOTALS	A	B	C
Connected VA	0	600	600
Demand VA	0	600	600
Connected Amps	0.0	5.0	5.0
Demand Amps	0.0	5.0	5.0

* 10kVA at 100%, remainder at 50%
** 100% plus 25% of the largest Motor

MECHANICAL EQUIPMENT CONNECTION SCHEDULE

TAG	DESCRIPTION	VOLTAGE	PHASE	HP	KW	AMP	FEEDER DESCRIPTION	CIRCUIT NO.	CIRCUIT BREAKER	STARTER	STARTER SIZE	DISCONNECT	VFD	NOTES
SF-1	SUPPLY FAN	208	3	15		46.2	3 #6 CU., 1 #6 GND. IN 1 1/4"C.	MDA	70/3	NA	NA	DIV 26	DIV. 23	1
SF-2	SUPPLY FAN	208	3	15		46.2	3 #6 CU., 1 #6 GND. IN 1 1/4"C.	MDA	70/3	NA	NA	DIV 26	DIV. 23	1
	COOLING TOWER FAN	208	3	3		10.6				NA	NA		DIV. 23	1
CT-1	COOLING TOWER SPRAY PUMP	208	3	1/2		2.4	3 #10 CU., 1 #10 GND. IN 3/4"C.	P-3 - 22	30/3	DIV 23	0	DIV 23	NA	2
	COOLING TOWER PAN HEATER	208	1		3	9.6				NA	NA		NA	3
CDP-1	CONDENSER WATER PUMP	208	3	3		7.5	3 #12 CU., 1 #12 GND. IN 3/4"C.	P-3 - 24	15/3	DIV 23	1	DIV 26	NA	1
CH-1	CHILLER	208	3		17.0	67A	2 SETS OF (3) #3/0 CU., 1 #1/0 GND. IN 3"C.	MDA	600/3	NA	NA	DIV 26	NA	6
CWP-1	CHILLED WATER PUMP	208	3	5		16.7	3 #10 CU., 1 #10 GND. IN 3/4"C.	SDA-1	30/3	NA	NA	DIV 26	DIV. 23	1
CWP-2	CHILLED WATER PUMP	208	3	5		16.7	3 #10 CU., 1 #10 GND. IN 3/4"C.	SDA-1	30/3	NA	NA	DIV 26	DIV. 23	1
EF-1	EXHAUST FAN - EAST	208	3	1		4.6	3 #12 CU., 1 #12 GND. IN 3/4"C.	(E) CIRCUIT	15/3	DIV 23	0	DIV 26	NA	4,5
EF-2	EXHAUST FAN - EAST	208	3	1		4.6	3 #12 CU., 1 #12 GND. IN 3/4"C.	(E) CIRCUIT	15/3	DIV 23	0	DIV 26	NA	4,5
EF-3	EXHAUST FAN - WEST	208	3	1		4.6	3 #12 CU., 1 #12 GND. IN 3/4"C.	(E) CIRCUIT	15/3	DIV 23	0	DIV 26	NA	4,5
EF-4	EXHAUST FAN - WEST	208	3	1		4.6	3 #12 CU., 1 #12 GND. IN 3/4"C.	(E) CIRCUIT	15/3	DIV 23	0	DIV 26	NA	4,5
GF-1	GLYCOL FEED PUMP	120	1	1/2		9.8	2 #12 CU., 1 #12 GND. IN 1/2"C.	P-3 - 6	20/1	DIV 23	0	DIV 26	NA	4
HT-1	HEAT TRACE	120	1		1	8.3	2 #12 CU., 1 #12 GND. IN 1/2"C.	(E) CIRCUIT	15/1	NA	NA	DIV 26	NA	

GENERAL NOTES
1. PROVIDE XHHW WIRE FROM VFD TO MOTOR, TYPICAL OF ALL VFD CONTROLLED EQUIPMENT.

NOTES:
1. VFD FURNISHED BY DIV 23 AND INSTALLED BY DIV 26. WIRING FROM SOURCE TO VFD AND FROM VFD TO MOTOR PROVIDED BY DIV 26.
2. CONTROL OF FAN HEATERS PROVIDED BY COOLING TOWER CONTROL PANEL. COORDINATE CONNECTION REQUIREMENT WITH MECHANICAL.
3. CONTROL OF SPRAY PUMP PROVIDED BY COOLING TOWER CONTROL PANEL. COORDINATE CONNECTION REQUIREMENT WITH MECHANICAL.
4. STARTER RELAY FURNISHED BY DIV 23 AND INSTALLED BY DIV 26.
5. INTERCEPT AND EXTEND EXISTING CIRCUIT PREVIOUSLY SERVING FAN COIL UNIT NEAR SAME LOCATION. PROVIDE FUSED DISCONNECT FOR EQUIPMENT.
6. PROVIDE FUSED DISCONNET FOR CHILLER UNIT. COORDINATE SIZE WITH EQUIPMENT MANUFACTURER.

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MAY 21, 2014
MATTHEW B. RETICH

Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

SCHEDULES

MARK	DATE	DESCRIPTION

DESIGNED: CCS
DRAWN: CCS
CHECKED: MBR

DATE: 11/13/2019
PROJECT: T049.11

E602

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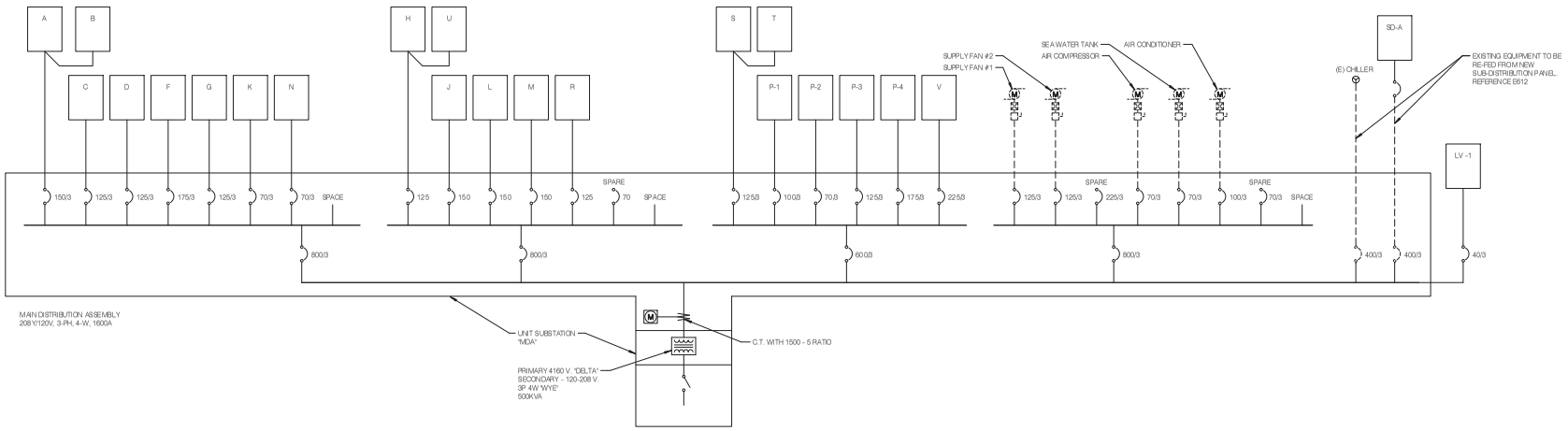

1 **ONE-LINE DIAGRAM - DEMOLITION**

NOT TO SCALE

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MAY 21, 2014
MATTHEW B. RUTCH

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Radiation Center

LOCATION:
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OWNER:
Oregon State University

ONE-LINE DIAGRAM - DEMOLITION

MARK	DATE	DESCRIPTION

DESIGNED: COS
DRAWN: COS
CHECKED: MBR

DATE: 11/13/2019
PROJECT: T049.11

E611

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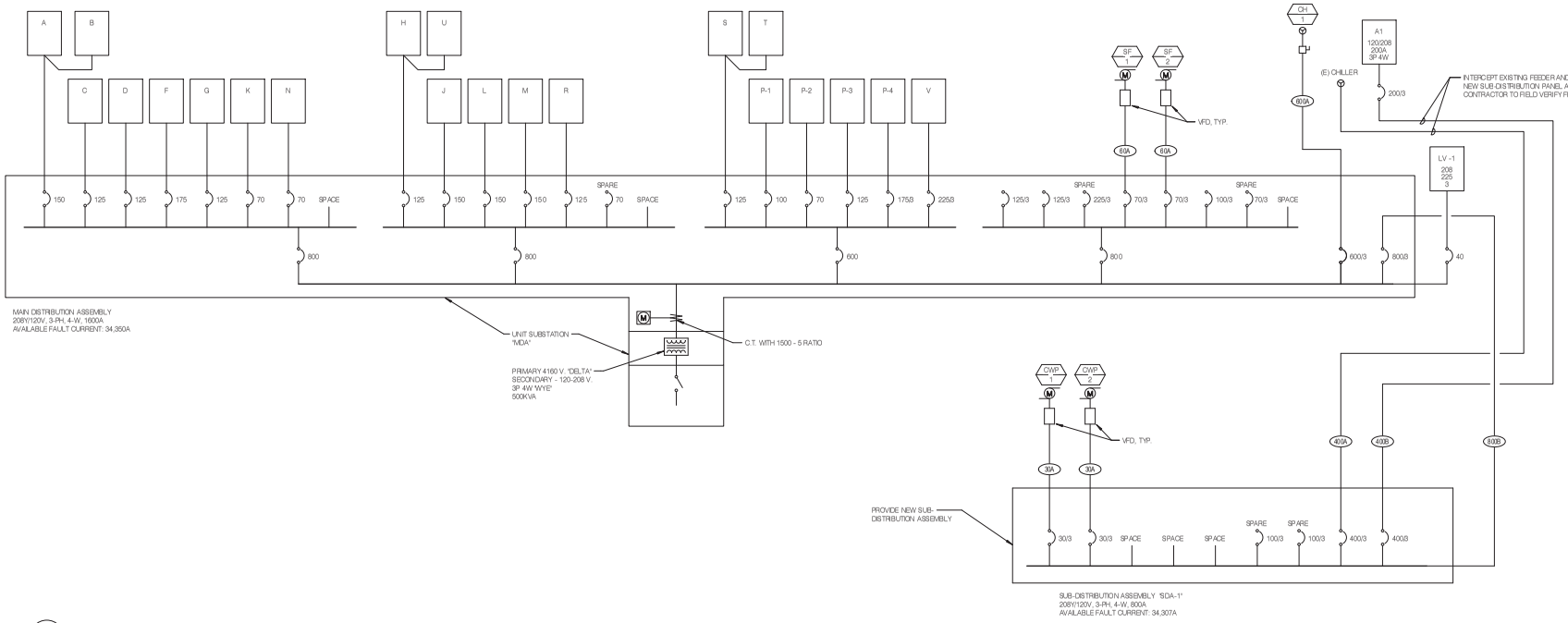

1 **ONE-LINE DIAGRAM - NEW**

NOT TO SCALE

FEEDER SCHEDULE

DISIG.	DESCRIPTION	COMMENTS
30A	3 #10 CU, 1 #10 GND, IN 3/4"C.	
60A	3 #6 CU, 1 #6 GND, IN 1" C.	
40/A	2 SETS OF (3 #3/0 CU, 1 #2 GND, IN 2-1/2" C).	
40/B	2 SETS OF (4 #3/0 CU, 1 #2 GND, IN 2-1/2" C).	
600A	2 SETS OF (3 #350 CU, 1 #1/0 GND, IN 3" C.)	
80/B	3 SETS OF (4 #600 CU, 1 #2/0 GND, IN 3 1 2" C.)	
KEY:		
T = 2 WIRE		
A = 3 WIRE		
B = 4 WIRE		

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MAY 21, 2020
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Cooling Design

Radiation Center

LOCATION:
3451 SW Jefferson Way
Corvallis, OR 97331

OWNER:
Oregon State University

ONE-LINE DIAGRAM - NEW

MARK	DATE	DESCRIPTION

DESIGNED: CCS
DRAWN: CCS
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DATE: 11/13/2019
PROJECT: T049.11

E612

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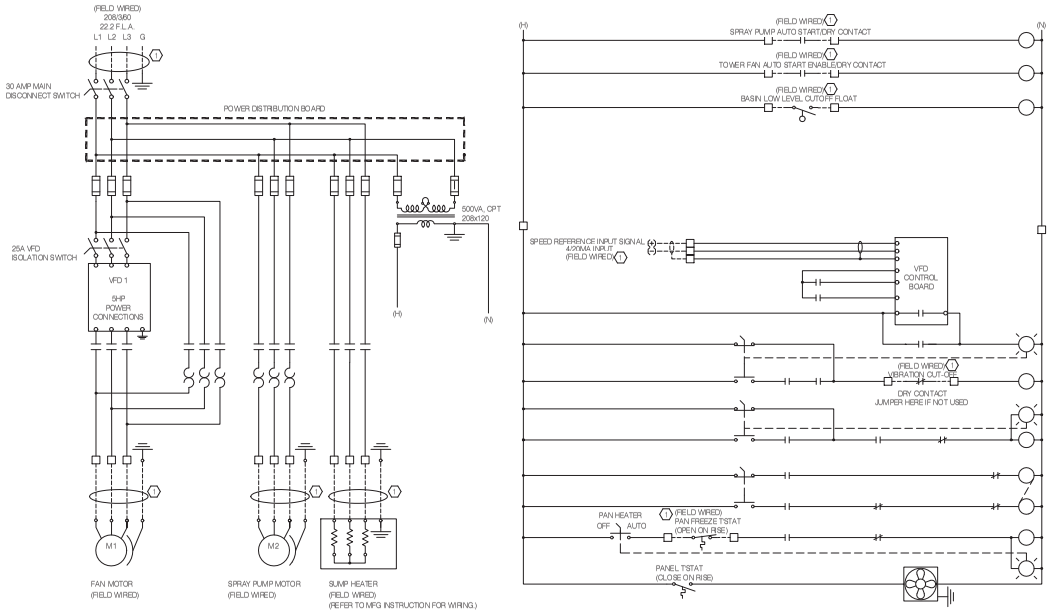

1 **CT-1 WIRING DIAGRAM**

NOT TO SCALE

REFERENCE NOTES:

1. DASHED LINES INDICATE FIELD WIRING PROVIDED BY DIVISION 26. TYPICAL

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MATTHEW B. RETCH
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OREGON
MAY 21, 2014
RENEWAL DATE: 12/31/20

Cooling Design

Radiation Center

LOCATION:
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WIRING DIAGRAMS

MARK	DATE	DESCRIPTION

DESIGNED:	COS
DRAWN:	CCS
CHECKED:	MBR
DATE:	11/13/2019
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E621

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