THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS
BRIGHAM YOUNG UNIVERSITY
STANDARD CONTRACT REQUIREMENTS
TABLE OF CONTENTS

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS

BRIGHAM YOUNG UNIVERSITY

STANDARD CONTRACT REQUIREMENTS

I. INVITATION TO BID

II. NOTICE TO BIDDERS

III. FORM OF PROPOSAL

IV. INSTRUCTIONS TO BIDDERS

V. FORM OF CONTRACT

VI. SALES TAX EXEMPTION CERTIFICATE

VII. GENERAL CONDITIONS TABLE OF CONTENTS

A. GENERAL CONDITIONS

B. SUPPLEMENTARY CONDITIONS

C. SUBCONTRACTORS (Not Applicable)

VIII. REQUEST FOR PAYMENT

A. SCHEDULE OF VALUES
16 March 2020

(Attached is a list of bidders invited to bid.)

Re: Invitation to Bid – LDS Motion Picture Studio Chiller Plant  
W.O. TBD

To Whom It May Concern:

You are invited to bid on the above-referenced project. This project consists of removing three existing chillers and constructing a central chiller plant and infrastructure to provide chilled water piping to the main building and three auxiliary buildings. The completion date for this project is July 17, 2020.

Plans will be available at the mandatory pre-bid which has been scheduled for March 24th at 2:00 p.m. in Room 115 BRWB. Bids will be opened and read aloud on April 7th at 2:00 p.m. in Room 115 of the Brewster Physical Facilities Building at Brigham Young University. A performance bond and a labor and materials payment bond for 100% of the contract will be required for this project and must be included in your bid.

We hope that you will be able to bid this project.

Sincerely,

Ole M. Smith

ARB/kb
Attachment
NOTICE TO BIDDERS

SECTION 1--PROJECT: LDS Motion Picture Studio Chiller Plant

WORK ORDER NUMBER: TBD

SECTION 2--LOCATION: Brigham Young University

SECTION 3--OWNER: Brigham Young University

SECTION 4--DESIGNER: Brigham Young University

SECTION 5--STANDARD CONTRACT REQUIREMENTS:

The Bidder is directed to the Church of Jesus Christ of Latter-day Saints, Brigham Young University Standard Contract Requirements (revised December 2013). This volume is an integral part of the contract documents and is hereby made a part of the contract.

SECTION 6--DATES:

A. Start Date: April 13, 2020

B. Completion Date: July 17, 2020

SECTION 7--PREBID CONFERENCE

A. Prebid Conference will be:

   Date: March 24, 2020
   Time: 2:00 p.m.
   Place: Room 115, Brewster Building

SECTION 8--RECEIPT AND OPENING OF BIDS:

A. Bids will be received:

   Date: April 7, 2020
   Time: 2:00 p.m.
   Place: Room 115, Brewster Building

   By: Ole M. Smith

B. The Owner reserves the exclusive right to release all publicity relating to the proposals and the project.

SECTION 9--DEPOSIT FOR CONTRACT DOCUMENTS:

A. A deposit of $0.00 will be required for each set of contract documents (plans and specifications) taken.

SECTION 10--GENERAL CONTRACTORS

A. Bidding by General Contractors will be by invitation only.
The undersigned, hereinafter referred to as the Bidder, certifies that the following facts and/or circumstances have occurred or exist relating to the proposed work:

1. That Bidder has received the contract documents for the above entitled project.
2. That Bidder has received The Church of Jesus Christ of Latter-Day Saints Brigham Young University General Conditions Requirements, revised October 7, 2016.
3. That Bidder is familiar with such documents, has examined the site of the proposed work, including availability of access, utilities, and other similar items relating to performance of the work and is thoroughly familiar with all general and local conditions which could in any way affect this work.
4. That no verbal agreements or representations with or by any officer, agent, or employee of the Owner exist or have been made to the Bidder and the Bidder in submitting this proposal is in no way relying thereon.
5. That if this proposal is accepted, Bidder will enter into a contract with the Owner in substantially the form contained in the contract documents, and will provide the bonds, insurance coverage and all other items required by the contract documents.
6. The term "base bid" shall be understood to include all work contained in the contract documents excluding any substitutes or alternates. The Owner will have the right to accept Alternates in any order or combination, and to determine the low Bidder on the basis of the sum of the Base Bid and Alternates accepted.

Bidder hereby proposes to furnish all materials, labor, equipment, tools, transportation, services, licenses and permits necessary for the completion of all the work set forth in the contract documents for the sum of:

Base Bid ($__

Alt No. 1: Extend Chilled Water Lines to Third Storage Building ($__

Cost of a Builder’s Risk Policy. Do not include in base bid. See Supplementary Conditions. ($__
1. The bidder agrees to complete the work on or before July 17, 2020

2. The bidder acknowledges receipt of addenda No.(s)

3. The Bidder’s Utah contractor’s license number is

4. Is your bonding capacity adequate for this job? Yes No

5. For verification call

6. Telephone number

PROPOSED SUBSTITUTE MATERIALS

The total sum of the Bidder's proposal shall include the furnishing and installing of all materials, equipment, and labor as called for in the contract documents as a base bid.

Hereafter give the total amount to be added or deducted for a complete installation of equipment or materials other than those specified and those approved by addendum are submitted for the Owner's consideration. All materials and equipment proposed for substitution shall be listed below and must meet the requirements of the contract documents. During the time of consideration of the proposals, complete information shall be submitted immediately to the Architect and Owner's Representative. The Contractor is referred to Page 3 of the Instructions to Bidders, Section 9, prior approvals and substitutions for requirements relative to proposed substitutions.

<table>
<thead>
<tr>
<th>Proposed Substitute</th>
<th>Manufacturer and Catalog Numbers</th>
<th>$ Add</th>
<th>$ Deduct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TYPE OF BIDDER'S ORGANIZATION:

Official Name of Organization

Corporation, Co-partnership, Individual, or Other

Address

Name of individual Members of Firm:

Name of President of Corporation:

Name of Secretary of Corporation:

Corporation is organized under the laws of the State of:

Signature

( ) Title or Office

)Seal( Legal Address

( )
BIDDER'S LIST OF SUBCONTRACT BIDS USED IN PROPOSAL

(LIST OF SUBCONTRACTORS)

PROJECT NAME  LDS Motion Picture Studio Chiller Plant

WORK ORDER NUMBER  TBD

OWNER'S NAME  Brigham Young University

<table>
<thead>
<tr>
<th>DIVISION</th>
<th>SUBCONTRACT CLASSIFICATIONS</th>
<th>SUBCONTRACTOR USED</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12/2013  Form of Proposal
INSTRUCTIONS TO BIDDERS

SECTION 1 -- BIDDING BY INVITATION

A. Bidding shall be by written invitation only. Those wanting to be considered for such invitation shall apply to:

Assistant Administrative Vice President
Physical Facilities
202 Brewster Building
Provo, UT 84602

B. The Owner reserves the right to accept or reject any or all bids.

SECTION 2 -- CONTRACT DOCUMENTS

A. The Contract documents may be obtained by contractors from:

Construction Department
Physical Plant
240 Brewster Building
Provo, UT 84602

B. Subcontractors and suppliers who want to obtain Contract documents (plans and specifications) may do so by requesting the documents and paying the printing costs.

C. All Contract documents must be returned within ten (10) days after the bid opening, or the deposit will be forfeited. Those documents purchased outright by the Bidders are exempted.

D. The Contract documents (plans and specifications) may be deposited with local Bid Depositories. Bidders may contact the Invited General Contractors for locations. The Contract documents may be examined free at:

Construction Department
Physical Plant
240 Brewster Building
Provo, UT 84602

SECTION 3 -- CONTRACT METHOD

A. All work specified is to be done under one general contract. Bids will be accepted by the Owner from prime contractors only.

SECTION 4 -- INTERPRETATION OF CONTRACT DOCUMENTS

A. If any Bidder doubts the true meaning of any of the Contract documents, or finds errors, discrepancies or omissions, he shall request a clarification from the Architect in writing. Any interpretations or corrections will be made only by written addenda duly issued by the Owner. All addenda will be mailed, faxed or otherwise delivered to each person receiving a set of the Contract documents. Requests for clarifications must be submitted to the Architect at least five (5) days before bid opening. Unwritten instructions or interpretations will have no validity.

B. Should discrepancies appear in the Contract documents that are not resolved by an addendum, it is expressly understood that the Contractor has used the most expensive method and/or material in the bid.

SECTION 5 -- REQUIREMENTS BEFORE SUBMITTING BIDS

A. The Contractor shall become thoroughly familiar with the site and structures located there (if any). The Contractor shall thoroughly examine all Contract documents in relation to all conditions that might directly or indirectly affect the contract work. The bid amount shall reflect all such conditions.
SECTION 6 -- PREPARING AND SUBMITTING BIDS

A. To receive consideration, a bid must be made according to the following instructions:

1. Bids shall be prepared on BYU bid forms.
2. Bids shall have all items or blanks filled. Numbers shall be stated both in writing and in figures. If there is a discrepancy between the two, the written number shall govern.
3. Bids shall be without interlineations, alterations or erasures.
4. Signatures shall be by those authorized to execute the Contract.
5. The Bidder's legal name, business address and telephone number shall be stated.
6. Neither oral bids nor modifications shall be considered.
7. You may email your bid to the Construction Department Secretary, but it is not official until it is printed, inserted into an envelope, and delivered to the designated person opening the bids prior to the appointed bid opening time. It is suggested that the bidder call in advance to make these arrangements. We do not accept responsibility for email, printing, delivery, or other problems.
8. It is the Bidder's sole responsibility to see that the bid is received at the proper time. Any bid received after the scheduled bid opening time will be returned unopened to the Bidder.
9. Bidders shall accept proposals from only those subcontractors who are approved by the Owner or those who have shown to the Bidder's satisfaction that they are financially capable of handling the work. Furthermore, subcontractors must have the technical ability, personnel, plant, experience and reputation to carry out their portions of the work. It will be assumed that the question of bonding subcontractors, where considered desirable or necessary by the Contractor, including the cost of such bonds, has been resolved before bids have been submitted.
10. In order for the bid to be considered valid, two or more Bidders bidding as a "joint venture" must have the written approval of the Owner before submitting a bid. All members of a joint venture shall sign the bid and an official representative of the joint venture shall be designated in the proposal.
11. The term "base bid" shall be understood to include all work contained in the Contract, excluding any alternates or substitutes. The Owner shall have the right to accept alternates in any order or combination, and to determine the low Bidder based on the sum of the base bid and alternates accepted.
12. Substitutes or alternates accepted by the Owner may be included in the Contract or added by Change Order. In determining the low Bidder, the Owner will not consider substitutes.
13. Bids may be withdrawn by the Bidder, either in person or by a written request before bid opening. Once opened, the Bidders will have 24 hours to review and withdraw their bids. After the 24-hour period, the bids may not be withdrawn and must remain fixed as submitted for 45 days after opening. Envelopes must contain nothing but the proposal and bid breakdown forms if required. Envelopes shall be opaque, sealed and bear the Bidder's name.

SECTION 7 -- APPROVAL OF CONTRACTORS AND SUBCONTRACTORS

A. As soon after the bid opening as is practicable, the Owner will interview the apparent low Bidder and if deemed advisable, the second or third low Bidders. Within two hours of the bid opening, the low Bidder and the second or third low Bidders will provide to the Owner a list of subcontractors and their dollar amounts that were used in formulating their bid. The list of subcontractors will be examined by the Owner as soon as possible. The Owner reserves the right to accept or reject any subcontract proposal.

B. Provide Unit Prices within 24 hours of Bid Opening if requested in Form of Proposal.

C. If a Bidder doubts the correctness or acceptability of any subcontract proposal, the Bidder may submit the names and amount of other competing subcontractors for consideration, making sure that he clearly states which one he has used in formulating his proposal.

SECTION 8 -- FACTORS AFFECTING AWARD OR REJECTION OF BID

A. The Bidder's and subcontractor's past performance, organization, equipment and ability to perform and complete their contract as specified will be vital elements, as well as the amount of their bids, in the award of the Contract.

B. The Owner reserves the right to reject any or all bids, or to waive any irregularities or informalities in bids received.
Owner reserves the right to accept the bid that will, in the Owner's opinion, best serve the interests of the Owner.

C. If a schedule is requested on form of proposal - The Owner reserves the right to reject a bid that provides a date that is past the requested substantial completion. Further, the Owner reserves the right to award the project based on proposed substantial completion regardless of whether such bid is the lowest.

SECTION 9 -- PRIOR APPROVALS AND SUBSTITUTIONS

A. Several acceptable brands of equipment, manufactured articles or methods of construction may have been identified in the Contract. It is not intended to close the Contract against other brands, articles, or methods that may warrant consideration. However, unspecified materials must have prior approval by the Owner to be considered.

B. Prior Approvals: Requests for approval of unspecified materials must be made to the Architect at least five days before bid opening. The requests for prior approval shall be considered by the Architect if time permits and if properly documented. The Architect is not bound to consider these items despite their apparent validity.

C. Fully detailed technical data, references and other information shall be furnished simultaneously with the requests for prior approval items.

D. Such requests shall be reviewed by the Architect and the Owner. If accepted, the approved requests will be included in an addendum.

E. The Contractor's "base bid" shall include the furnishing of only those items that are explicitly specified or which have received prior approval by addendum.

F. Substitutions: Besides the "base bid," any equipment or material supplier and any contractor or subcontractor may, at his option, submit a substitute price and product for any item specified which he feels warrants consideration by the Owner. This proposed substitution is to be listed where indicated on the bid form.

G. Any proposed substitute submitted by a Bidder shall include the amount by which the "base bid" would be increased or decreased.

H. The Owner may accept or reject any substitute proposed. In determining the low Bidder, the Owner will not consider substitutes.

I. If requested, the Contractor shall furnish information or data concerning the substitute. The Owner may request the Contractor, at his own expense, to have the substitute tested by an approved testing laboratory.

SECTION 10 -- FORM OF CONTRACT

A. Copies of the form of the Contract that the successful Bidder will be required to execute are included in this specification.

SECTION 11 -- ADDENDA

A. All addenda issued before bid opening shall be included in the bid and shall be a part of the Contract.

SECTION 12 -- REQUIREMENTS IMMEDIATELY AFTER SIGNING THE CONTRACT

A. Immediately after signing the Contract, the Contractor shall furnish the following to the Owner:
   1. Executed performance, labor and material payment bonds, each in an amount equal to 100 percent of the contract sum as specified in the General Conditions.
   2. Insurance certificates as specified in the General Conditions.
   3. A cost breakdown of the work that may, as approved by the Owner, serve as a basis for making monthly payments to the Contractor.
   4. A project schedule as to how he intends to construct the project. This must be, in the opinion of the Owner, a realistic method of analyzing and scheduling each component of the work. It must show when all trades or crafts start and finish their work. This schedule must be reviewed weekly in the OAC meeting and updated as
required. A critical path method of scheduling is preferred. If the Contractor cannot produce and maintain such a schedule, this service must be obtained from an outside consultant. The schedule must be approved by the Owner's Representative before the Contractor submits the first payment request.

B. The Contractor shall issue subcontracts as mutually agreed between the Owner and the Contractor. A complete list of subcontractors and major suppliers including names, addresses and telephone numbers are required within fourteen (14) days of the Owner=s subcontractor review.

SECTION 13 -- DISQUALIFICATION

A. If the above requirements are not satisfied, the bid may be disqualified at the discretion of the Owner.
CONTRACT

AT

BRIGHAM YOUNG UNIVERSITY

LONG FORM CONTRACT NO.

Project No.: 
(Work Order No.: )

THIS CONTRACT, made and executed as of the day of , by and between BRIGHAM YOUNG UNIVERSITY, a non-profit Utah corporation of Provo, Utah (hereinafter referred to as "Owner"), and (hereinafter referred to as "Contractor").

WITNESSETH:

That for and in consideration of the payments hereinafter specified to be paid by the Owner to the Contractor and the covenants and agreement herein contained to be kept and performed by the parties hereto, the Contractor agrees to build and construct the proposed at Brigham Young University in Provo, Utah (hereinafter referred to as the "Project") and to furnish and deliver all materials, and perform and supervise all services (hereinafter, the “Work”) as required herein and by the contract documents hereinafter identified, all of which shall collectively constitute the contract, and shall hereinafter be referred to collectively as the "Contract".
ARTICLE I.  THE IDENTIFICATION OF CONTRACT DOCUMENTS

A. The Plans entitled were prepared by and approved by Ole Smith, Assistant Administrative Vice-President of Brigham Young University, on .

B. The Specifications entitled were prepared by and approved by Ole Smith, Assistant Administrative Vice-President of Brigham Young University, on

C. Addendum Number One, dated .

D. Addendum Number Two, dated .

E. The Brigham Young University General Conditions are a part of this Contract.

ARTICLE II.  THE CONTRACT SUM

The Owner agrees to pay to the Contractor, in accordance with the terms hereof, the following:

<table>
<thead>
<tr>
<th>Base Bid</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>$</td>
</tr>
</tbody>
</table>

The Contractor agrees to accept a total of Dollars ($ ) as full compensation for performing his obligation under the contract.

ARTICLE III.  DATE OF COMPLETION

The Contractor agrees to complete the work required by the Contract on or before midnight, . Time is hereby expressly declared to be of the essence of the Contract.

ARTICLE IV.  THE CONTRACTOR'S REPRESENTATIVE

The Contractor's Representative is .
ARTICLE V.  THE OWNER'S REPRESENTATIVE

The Owner's Representative is Ole M. Smith.

IN WITNESS WHEREOF, the Owner has caused this instrument to be signed by its President, attested by its Secretary, and its corporate seal to be hereunto affixed, and the Contractor has hereunto affixed his signature as of the day and year above written.

ACKNOWLEDGED:              BRIGHAM YOUNG UNIVERSITY

__________________________________    _______________________________________
Ole M. Smith               Kevin J. Worthen, President

__________________________________    Contractor
Brian K. Evans

________________________________________
Pursuant to Utah State Tax Commission Rule R865-19S-58, Brigham Young University is exempt from sales/use tax on purchases of all Construction Materials (as defined by the above Rule). You and your subcontractors are hereby authorized to purchase Construction Materials free of Utah sales tax for the Project listed below pursuant to the agreement between you and Brigham Young University dated ____.

PROJECT: ________________________________

OWNER’S REPRESENTATIVE: Assistant Administrative Vice-President
202 BRWB, Provo, UT 84602-8100
(801) 422-5500

CONTRACTOR’S (OR SUB’S) AFFIDAVIT

TO (Name of Vendor): ________________________________

I certify that the purchases of Construction Materials from the Vendor above are made in behalf of Brigham Young University for the above referenced Project only. I further certify that the Construction Materials purchased will be installed or converted into real property owned by Brigham Young University.

NAME OF CONTRACTOR/SUB: ________________________________

Street Address: ________________________________ Phone: __________
Address City State/Zip

By: ________________________________ Title: ________________________________ Date: 
Authorized Representative Position or Job Title

NOTE: Vendor must keep this certificate on file for audit review. Contractor or Sub must keep a copy of this certificate on file and must notify vendors of cancellation, modification, or limitation of the exemption claimed. Contractor or Sub is liable for sales tax on any Construction Materials purchased which are not used on the Project above or which do not otherwise qualify for exemption.
GENERAL CONDITIONS

SECTION 1 - DEFINITIONS

A. OWNER - Brigham Young University, Provo, UT, referred to as the "Owner."

B. OWNER'S REPRESENTATIVE - The Assistant Administrative Vice President - Physical Facilities, 202 Brewster Building, Brigham Young University, Provo, UT 84602.

C. ARCHITECT - The Architect is a licensed architect, engineer, or organization so designated in the Contract. The term "Architect" means the Architect or his authorized representative.

D. CONTRACTOR - The Contractor is the person or organization identified as such in the Contract and referred to throughout the Contract as if singular in number and masculine in gender. The term "Contractor" means General Contractor or his authorized representative.

E. SUBCONTRACTOR - The person, firm or corporation supplying direct or indirect labor and/or materials at the site of the Project and under separate contract or agreement with the Contractor.

F. PROJECT MANAGER - The BYU personnel who acts as liaison between the Owner and the Contractor for the Project. [CITY INSPECTOR ISSUE]

G. THE WORK - The work includes all labor necessary to produce the construction, demolition, or other delivery of goods and services required by the Contract and all materials and equipment incorporated or to be incorporated in such work.

H. THE PROJECT - The Project is the total construction designed by the Architect. The Work performed under the Contract may be the whole or a part of the work required to be performed under the Project.

I. WRITTEN NOTICE - Written notice shall have been duly served if delivered in person to the Project Manager or the Contractor's designated representative. Written notice is also served by a registered or certified mailing to the last known address of the corporation, if delivered to the direction of the Project Manager or the Contractor's designated representative.

J. CONTRACT - The Contract consists of the Brigham Young University short or long form contract; the Instructions to Bidders; the Supplementary Conditions; the General Conditions; the Drawings; the Specifications; Addenda; and Change Orders describing the Work and signed or acknowledged between the Owner and Contractor.

SECTION 2 - THE CONTRACT DOCUMENTS

A. The Contract represents the entire agreement between the parties and supersedes all prior negotiations, representations or agreements, either written or oral, including the bidding documents. After written execution of the Contract, the Contract shall be amended or modified only by a Change Order.

B. Words that have well-known technical or trade meanings are used herein by such recognized meanings.

C. Within the Contract there shall be the following order of precedence, (1) being the highest precedent:
   1. The BYU Short Form or Long Form Contract takes precedence over all other documents.
   2. Supplementary General Conditions take precedence over General Conditions.
   3. General Conditions take precedence over Drawings and Specifications.
   4. Addenda or modifications of any nature, to the Drawings and Specifications, take precedence over the original.
5. Specifications take precedence over Drawings.
6. Within the Working Drawings, the larger scale takes precedence over smaller, figured dimensions over scaled and noted materials over graphic indications.

SECTION 3 - DISCREPANCIES IN THE CONTRACT

A. Should any question arise regarding the Contract, the Contractor shall request written interpretation and clarification from the Architect before proceeding. Without such request and written authorization, the Contractor proceeds at his own risk.

SECTION 4 - ADDITIONAL DRAWINGS & INSTRUCTIONS

A. The Architect shall promptly furnish any additional instructions or clarification necessary for proper execution of the Work specified in the Contract.

SECTION 5 - OWNERSHIP AND MAINTENANCE OF DRAWINGS

A. All drawings and specifications furnished to the Contractor, including electronic file versions, are the property of the Owner. They are not to be used on other work and must be returned to the Owner if so requested. One copy may be retained by the Contractor, but may not be used for any third-party work without the express written consent of the Owner.

B. The Owner shall furnish, free of charge to the Contractor, all copies of drawings and specifications reasonably necessary for the execution of the Work. The Contractor shall maintain in good order on the Project one copy of drawings, addenda and specifications that shall be readily available to the Architect and the Project Manager.

SECTION 6 - PROGRESS MEETINGS

A. Contractor shall be required to attend weekly Owner, Architect, and Contractor (OAC) meetings. The agenda and meeting minutes will be prepared by the Architect. The Architect shall distribute meeting minutes within seven days of the meeting. The Contractor shall attend such meetings and shall require subcontractors to attend as necessary. These meetings are to:
   1. Insure that all activities are being coordinated properly on the Project.
   2. Review the schedule.
   3. Check the status of:
      a. Submittals, including shop drawings and samples.
      b. Change Orders and Proposal Requests.
      c. Payment requests.
      d. Any other matters that may need to be reviewed.

SECTION 7 - PROJECT SCHEDULE

A. Before the first payment request, the Contractor shall prepare and submit for review an estimated Project schedule for the Work. The Project schedule shall be in sufficient detail to include, but not be limited to:
   1. Significant elements of the Work.
   2. Period for each element of Work with a beginning and ending date.
   3. Percentage of progress of Work completed or to be completed in a monthly period.
   4. Early start anticipated schedule of all Owner Provided/Contractor Installed (OP/CI) mechanical controls.

B. The Project schedule shall be updated monthly and submitted with each payment request and shall show the original Project schedule or revised Project schedule, one entry for each item of work, as follows:
   1. All Work already completed and paid for by Owner.
2. Work during current period for which payment is being requested.
3. Remaining Work to be done, itemized in the Schedule of Values.

SECTION 8 - EMERGENCIES

A. In case of an emergency endangering life or threatening the safety of the structure or of adjoining property, the Contractor may, without waiting for specific authorization from the Architect or Owner, act at his own discretion to safeguard life or property. Compensation and time shall be allowed the Contractor for such emergency work. The amount of both shall be decided between the Contractor, the Architect, and the Owner.

B. The Contractor shall notify the Project Manager immediately and shall make a full written report of such emergency action to the Project Coordinator within seven days of the event.

SECTION 9 - SUBMITTALS, SHOP DRAWINGS, AND SAMPLES

A. General:
   1. The Contractor shall deliver submittals, shop drawings or samples to the Owner and Architect as indicated below. Furthermore, the Contractor shall accompany each submittal with a transmittal letter indicating the title of the Project, the name of the Contractor, the title of the submittal and the specification section number.

B. Submittal Schedule:
   1. The Contractor shall, within twenty-one (21) calendar days after receipt of the signed contract, furnish a submittal schedule listing all items that the Contract requires for review. This schedule shall include shop drawings, manufacturers' literature, certificates of compliance, material samples, material colors, guarantees, etc.
   2. The schedule shall show the type of item, the Contract requirement reference, the Contractor's scheduled dates for submitting the items and the projected need dates for review by the Architect. The schedule shall show a minimum of fourteen (14) calendar days for review by the Architect. If resubmittal is required, an additional seven (7) days will be allowed. The Contractor shall revise and update this schedule as appropriate and submit it with each payment request until all items have been submitted and reviewed.
   3. The Contractor shall coordinate the submittal schedule with the Project schedule for all the work. The Contractor shall revise and update the submittal schedule to insure consistency with the Project schedule. The Contractor shall promptly provide such revised submittal schedules to the Owner.
   4. Furnishing of the submittal schedule or subsequent revisions shall not be interpreted as relieving the Contractor of the obligation to comply with all Contract requirements for items on the schedule.

C. Definitions:
   1. Shop drawings are drawings, diagrams, illustrations, electronic files, schedules, performance charts, brochures and other data prepared by the Contractor or subcontractor, manufacturer, supplier, or distributor. Shop drawings illustrate some portion of the work and confirm dimensions and conformance to the Contract.
   2. Samples are physical examples furnished by the Contractor to illustrate materials, equipment, color, or construction and to help establish standards by which the work will be judged.

D. Procedure:
   1. The Contractor shall review and stamp his certification that the products and methods meet the requirements specified in the Contract. The Contractor shall submit one (1) electronic copy of shop drawings to the Architect and one (1) electronic copy to the Owner, with reasonable promptness and in orderly sequence. Shop drawings and samples not required by the Contract
but requested by the Contractor, or supplied by those under contract to him, need not be submitted to the Architect and Owner for approval. These shop drawings shall meet all specified shop drawing requirements, except those relating to submission to the Architect and Owner.

2. The Contractor shall reject shop drawings not in conformance with the Contract.

3. Shop drawings shall be complete and detailed. If reviewed by the Architect, each copy of the shop drawings shall be stamped and dated by the Architect. If review "with exception" or "as noted" by the Architect is so identified, stamped and dated, the Contractor shall comply with notations shown. If the Architect requires resubmission of submittals, the Contractor shall make any corrections at the Contractor's expense. The Contractor shall not copy Project drawings and use those drawings as submittals.

   a. Any shop drawing which does not conform to the Contract shall be explicitly noted on the drawings and in the transmittal letter. This shall not be construed as approval to proceed with performing or providing the changed work until specifically approved by the Owner and a Change Order accordingly issued. If shop drawings show variations from Contract requirements because of standard shop practice, or for any other reason, such variations shall be explicitly noted in the transmittal letter. Shop drawing review shall be general. It shall not relieve the Contractor of responsibility for accuracy of such shop drawings, nor for proper fitting, construction of work, furnishing of materials or work required by Contract and not shown on shop drawings.

   b. All transmittal of shop drawings may be by email or other electronic means.

E. By approving shop drawings and samples, the Contractor determines and certifies that all field measurements, field construction criteria, materials, catalog numbers and similar data conform to the Contract. The Contractor determines and certifies that he has checked and coordinated each shop drawing and sample with requirements of the Contract.

F. No work requiring a shop drawing or sample submission shall be commenced until submission has been approved in writing by the Architect.

G. Samples:

1. Where specified or required, the Contractor shall submit samples to the Architect with specification material, affidavits, and other documentation as required by the Architect or the Owner.

2. It is the Contractor's specific responsibility to ascertain that samples have been checked and approved before being submitted.

3. Cost of samples, including transportation, delivery and any other costs, shall be paid by the Contractor. Unless specified otherwise, samples shall be submitted in triplicate for the Architect, the Owner and the Contractor. The Contractor shall keep his samples on the jobsite. Where samples are specifically required to be submitted for approval, no work involving the sampled materials shall proceed until written approval has been obtained from the Architect.

H. Review by the Architect and the Owner:

1. Review of shop drawings by the Architect and the Owner shall not be construed as a complete check, but will show only that the general method of construction and detailing is satisfactory. Review of such drawings will not relieve the Contractor of responsibility for any error that may exist in the submittals.

SECTION 10 - ROYALTIES & PATENTS

A. The Contractor shall pay all royalties and license fees. The Contractor shall defend and hold the Owner harmless from all suits or claims for infringement of any patent rights.

SECTION 11 - CONTRACTOR'S LIABILITY INSURANCE AND BONDS

A. Insurance:
1. The Contractor shall not commence work under this Contract until he has obtained the insurance required and evidence of such insurance has been submitted to and approved by the Owner. The submittal of said evidence to the Owner shall not relieve or decrease the liability of the contractor.

   a. Workers' Compensation & Employers' Liability Insurance as required by statute.
   b. Commercial General Liability Insurance – the current version of ISO Form CG 00 01 or equivalent, Occurrence Policy, with -
      (1) Limits of not less than -
         (a) General Aggregate $ 2,000,000.00
         (b) Products - Comp/OPS Aggregate $ 2,000,000.00
         (c) Personal and Advertising Injury $ 1,000,000.00
         (d) Each Occurrence $ 1,000,000.00
         (e) Fire Damage (any one fire) $ 50,000.00
         (f) Medical Expense (any one person) $ 5,000.00
      (2) Endorsements attached thereto including the following or their equivalent -
         (a) The current version of ISO Form CG 25 03, Amendment of Limits of Insurance (Designated Project or Premises), describing the subject Contract and specifying the limits as shown above.
         (b) The current version of ISO Form CG 20 10, Additional Insured -- Owners, Lessees, or Contractors (Form B), naming the Owner as an additional insured and containing the following statement - "This endorsement also constitutes primary coverage in the event of any occurrence, claim, or suit."
   c. Automobile Liability Insurance, with -
      (1) Limits of not less than $1,000,000.00 Combined Single Limit per accident.
      (2) Coverage applying to any auto.

B. Certificate of Insurance, on the current version of ACORD 25-S Form, or equivalent, filed with the Owner identifying:
   1. Owner, as defined in the Construction Contract, as Certificate Holder and Additional Insured.
   2. Endorsements, as listed above. (Note: If forms other than ISO forms are used, copies of the non-ISO forms are to be attached to this certificate).
   3. Project as defined in the Construction Contract.
   4. Cancellation clause of the certificate amended to read, "Should any of the above described policies be canceled before the expiration thereof, the issuing company will mail a notice within thirty (30) days to the certificate holder named."
   5. Insurance companies providing coverage - All companies listed must be rated "A-" or better in the Standard and Poor's Solvency Review Guide Property & Casualty (current edition.)
   6. The Name, Address, and Telephone Number of The "Producer" - The certificate is to bear an original signature of the Authorized Representative of the Producer. Facsimile or mechanically reproduced signatures will not be accepted.

C. Performance Bond and Labor & Material Payment Bond:
   1. The Contractor shall furnish the Owner a performance bond, and a labor and a material payment bond each in an amount equal to 100 percent of the Contract amount as security for all obligations arising under the Contract. Such bonds shall –
      a. Be written on Form AIA Document A312. Where the laws of the state in which the project is located mandate a statutory payment bond form, such mandated payment bond form shall be used but is to be accompanied by the AIA Document A312 Performance Bond.
      b. Be issued by a surety company or companies licensed in the state in which the Project is located and holding valid certificates of authority under applicable federal insurance law as acceptable sureties or reinsurance companies on federal bonds. The penal sum
obligation assumed by each surety, shall not exceed the maximum amount permitted by law.
c. Be accompanied by a certified copy of the Power of Attorney stating the authority of the
Attorney-in-fact executing the bonds on behalf of the Surety.

D. The Owner reserves the right to reject any insurance company, policy, endorsement, certificate of
insurance, surety company, performance bond, or labor and material payment bond with or without cause.

E. The cost of such insurance and such bonds as required above shall be the obligation of the Contractor.

SECTION 12 - HOLD HARMLESS AGREEMENT

A. Besides obtaining insurance coverage as required above, the Contractor shall indemnify and save the
Owner, the Architect, and their agents and employees harmless from and against any liability, demands,
causes of action or claims thereof, whether well founded or otherwise, including the cost of defending the
same, for bodily injury to any person whosoever (including the employees of the Owner or the Architect)
or damage to property of any person during construction because of the negligence of the Contractor, their
subcontractors or material suppliers, their agents or employees.

B. The Contractor shall defend the Owner and Architect in any lawsuit filed by any of their subcontractors or
material suppliers. Where liens have been filed against the Owner's property, this shall require the
Contractor or his bonding company to obtain lien releases and record them in the appropriate county or
local jurisdiction so as to unencumber and provide the Owner with a title free and clear from any liens.

C. No subcontract shall relieve the Contractor of any of his liability or obligation under the Contract. The
Contractor agrees that he is fully responsible to the Owner for acts or omissions of his subcontractors and
their material suppliers and of persons either directly or indirectly employed by them.

SECTION 13 - BUILDERS RISK LOSSES

A. The Owner will provide Builder’s Risk Insurance or reimburse the Contractor for losses to the Project,
described herein, to the extent to which such losses are or would be covered by the Owner’s Policy Form of
F.M. Global’s “All Risk” insurance policy covering Builders Risk Insurance.

1. Deductible Clause - All claims for loss or expense arising out of one occurrence shall be
adjusted as one claim, and from the amount of such adjusted claim, there shall be deducted the
sum of:
   a. $2,500.00 on all Projects. The deductible amount is the responsibility of the Contractor or
      Subcontractor.

2. Loss Reporting Procedure - All losses requiring reimbursement under this Section shall be
reported to the Project Coordinator as soon as practical and always before the beginning of
repairs so that details of the loss can be obtained and verified to simplify a prompt loss
adjustment.

B. Copies of the insurance forms are available from the Owner at the Brigham Young University Physical
Facilities, Construction Section offices.

SECTION 14 - PERMITS, INSPECTIONS, CERTIFICATES, AND REGULATIONS

A. Permits:

1. The Contractor shall obtain, and the Owner shall pay cost of, permits necessary for completion of
this work. “Permits,” as used in this paragraph includes any permits necessary for the Contractor
to complete the Work, including but not limited to: excavation, footing, and foundation permits;
building permits; hot work permits; elevator permits; fire sprinkler permits; boiler permits;
demolition permits; specialty permits from the State of Utah or other federal or state
governmental entities, such as Health Department permits; etc. The responsibility for obtaining, and any resulting liability for failing to obtain, such permits shall rest with the Contractor.

2. The Contractor shall schedule and coordinate all necessary inspections and shall notify the Project Manager and the Authority Having Jurisdiction of all inspections. The Contractor shall be responsible for securing a certificate of occupancy that may be required by Authorities Having Jurisdiction over the Work. The Contractor shall deliver these certificates to the Project Manager before execution of the Certificate of Substantial Completion.

3. The Contractor will be required to notify the Utah Division of Air Quality of any demolition projects and obtain all permits required by the State, County, and/or Provo City. The Contractor shall include all demolition permit fees in his bid.

4. The Contractor shall hold harmless, defend, and indemnify Owner from and against any and all claims, demands, allegations, fines, and damages associated with or arising from the Contractor’s failure to obtain required permits.

B. Regulations:

1. The Contractor and others working under his jurisdiction, supervision, or control shall do all work according to laws, regulations, and ordinances required by governmental authority or other agencies having jurisdiction over this work.

2. If the Contractor observes that the Contract is in variance with any laws, regulations or ordinances, he shall notify the Project Manager and shall not proceed unless necessary changes required for compliance with said laws, regulations and ordinances have been made as provided in the General Conditions, Section 24. The Contractor shall be fully responsible for any work knowingly done contrary to laws, regulations and ordinances. The Contractor shall fully indemnify the Owner against loss and bear all costs and penalties arising from those violations.

3. The Contractor shall hold harmless, defend, and indemnify Owner from and against any and all claims, demands, allegations, fines, and damages associated with or arising from the Contractor’s failure to follow applicable regulations.

SECTION 15 - MEASUREMENTS, SURVEYS, BUILDING LAYOUT & SITE EXAMINATION

A. The Contractor shall be responsible for:

1. Establishing lot lines and bench marks.
2. Laying out the work on the building site.
3. The proper observance of property lines and set back requirements.
4. The location and layout of buildings as noted in the drawings with respect to the position on the property and elevation in relation to the grade.

B. If existing conditions shown in the Contract documents differ materially from those the Contractor encounters in the performance of the work, the Contractor shall immediately notify the Architect and the Owner in writing.

C. The Architect and the Owner shall promptly investigate the reported conditions. If they find that such conditions do materially differ and cause an increase or decrease in the Contractor’s cost or the time required for performance of any part of the work, the Owner shall make an equitable adjustment by Change Order.

D. As the work progresses, the Contractor shall lay out on the forms, or floors, the exact locations of all partitions as a guide to all trades. Subcontractors providing work that is to be placed in connection with walls and/or partitions shall check such locations and immediately notify the Contractor of any conflicts in structure or changes necessary to adapt services, utility lines or equipment required by the Contract. Subcontractors and others failing to make such checks and give notice as outlined above shall be required to assume any costs resulting from their failure to do so.

E. Before ordering materials or doing work, the Contractor shall verify all measurements to properly size or fit
the work. No extra charge or compensation will be allowed by the Owner resulting from the Contractor's failure to comply with this requirement.

SECTION 16 - INSPECTION OF WORK

A. The Architect, Owner, and other inspectors or government officials as appropriate shall always have full access to all phases of the work. The Contractor shall provide adequate means to simplify inspection.
   1. The Contractor shall notify the Project Manager and local authorities twenty-four (24) hours before doing work that covers or otherwise makes it difficult to inspect structural, plumbing, mechanical, electrical, or other work.
   2. Should any of the work be covered before it is inspected by Project Manager and local authorities, the Contractor shall uncover that work for inspection at his own expense.
   3. The Contractor shall schedule the work so that an inspection team may inspect the mechanical, electrical, and plumbing work before it is covered up. This inspection team will furnish a list of items that must be completed before the work is concealed.

SECTION 17 - SUPERVISION & CONSTRUCTION PROCEDURES

A. The Contractor shall be solely responsible for all construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the work under the Contract. The Contractor shall not change project managers or superintendents without the written consent of the Owner.

SECTION 18 - ARCHITECT'S STATUS AND DECISIONS

A. The Architect shall assist the Project Manager during the construction period.
   1. The Architect will make frequent visits to the site to familiarize himself with the progress and quality of the work and to determine if the work is proceeding according to the Contract and schedule. During periodic visits the Architect may condemn work that fails to conform to the Contract.
   2. The Architect shall interpret the conditions of the Contract and be the judge of its performance. He shall use his powers under the Contract to enforce its faithful performance by the Contractor. The Architect will review shop drawings and prepare Proposal Requests. The Architect will conduct inspections with the Project Manager to determine the dates of substantial completion and final completion.
   3. In general, the Architect shall work with and coordinate with the Project Manager and the Contractor for the accomplishment of the Work. However, in the event that the Architect and Project Manager disagree on how a work should be accomplished, the Contractor shall take final direction from the Project Manager.
   4. Neither the Owner nor the Architect will be responsible for construction means, methods, techniques, sequences or procedures, or for safety precautions and programs concerning the Work. Neither the Owner nor the Architect will be responsible for failure of the Contractor, subcontractor, material supplier or their employees to carry out the Work according to the Contract.

SECTION 19 - MATERIAL & EQUIPMENT

A. DELIVERY, STORAGE, & HANDLING
   1. Materials shall be delivered to the site in original packaging with labels and trademarks intact, and such labels and trademarks shall remain intact until used. Structural steel, piping and fittings shall be manufactured in the United States of America.
   2. The Contractor shall confine his apparatus, storage of materials, and operations of his workers to limits indicated by law, ordinances and permits. The Contractor shall arrange and maintain storage of materials within contract limit lines in an orderly manner leaving all walks, driveways, roads and entrances unencumbered. The Contractor and the Contractor's employees shall park
only in the areas designated by Owner.
3. All new and existing equipment on the site shall be protected from physical damage and from the elements by measures satisfactory to the Architect and the Project Coordinator. All rotating equipment shall be rotated four turns weekly during construction.
4. If any material is found not conforming to the Contract, the Contractor shall remove such nonconforming materials at his expense.

B. PRODUCT OPTIONS & SUBSTITUTIONS
1. When several materials are specified in the Contract by name for one use, the Contractor may select any one of those so specified. The mixing of different products specified by name for one use is prohibited.
2. Items and material not specified in the Contract shall be removed and replaced by specified items and material at no additional cost to the Owner. No additional time will be added to the Contract for removal or replacement.
3. Wherever words "approved by," "satisfactory to," "submitted to," "inspected by," or similar phrases are used in this specification, they shall be understood to mean that the material or item referred to shall be approved by, be satisfactory to, submitted to, or inspected by the Architect and the Project Manager.

SECTION 20 - TEMPORARY CONSTRUCTION FACILITIES

A. TEMPORARY ELECTRICITY
1. The Contractor shall arrange with the proper authority (State, County, City, Owner, etc.) for all power required by the Contractor during the construction period until the Certificate of Substantial Completion is issued. If the power is coming from a BYU owned source, it will be paid for by BYU with the exception of the installation cost of equipment, conduit, wire, etc. BYU may provide transformer(s) and meter(s) at their discretion. Contractor to coordinate with BYU Construction Project Manager prior to bid. If no coordination takes place prior to bid, contractor is to provide transformer and meter at no additional cost to the owner after bid. Contractor shall bare the cost of any damages to owner provided equipment due to contractor's negligence. The method of metering, connections, etc., must have the written approval of the authority furnishing the utility to the Contractor. The Contractor shall be responsible for all utilities needed for his use during the entire construction period.
2. The Contractor shall provide all temporary wiring, outlets, metering (if the source of power is other than a BYU source), and associated materials. The temporary electrical system shall comply with local codes and the current, adopted version of the National Electrical Code.
3. The Contractor shall provide electrical power to distribution centers only.
4. If utility service is available from the Owner's permanent utilities, the Contractor may, by arranging with the Owner, use these permanent utilities. The Owner assumes no responsibility for damage caused by the Contractor using any of the Owner's utilities due to interruption of services by the Owner, whatever the cause.
5. The contractor may not use BYU provided power for welding equipment or other major equipment without written approval of BYU. Anything needing power other than for small tools, temporary lighting and project start up and function of permanent equipment (for example: elevator and mechanical equipment) shall be approved in writing by the BYU project Manager.

B. TEMPORARY LIGHTING
1. The Contractor shall provide wiring, outlets and fixtures for temporary lighting.
2. The Contractor shall provide pigtails and other lights for all areas within and around the building, sufficient to meet OSHA regulations, or to provide the following intensities, whichever is greater:
   a. All working areas 3 foot candles
   b. Stairs, landings, ramps 5 foot candles
   c. Outdoor floodlighting within contract limit lines 3 foot candles
   d. All areas involving finish work 30 foot candles
C. TEMPORARY HEATING, COOLING & VENTILATING
   1. All temporary heating and cooling shall be arranged and paid for by the Contractor. Heating and cooling from the central plant will be charged at $12.00 per million BTUs, if available and payable monthly to the Owner. BYU will provide the meter and contractor will install.
   2. New Additions and New Buildings:
      a. The Contractor shall be responsible for installation and operation of temporary heating, cooling, and ventilating units including fuel, temporary piping, fittings, wiring, and connections in new additions and new buildings as necessary.
      b. The Contractor shall be responsible for damage to building and contents caused by cold, heat, and dampness.
      c. The Contractor shall maintain safe conditions for use of temporary heating, cooling, and ventilating systems including, but not limited to, the following:
         (1) Operate equipment following the manufacturer's instructions.
         (2) Provide fresh air ventilation required by the equipment manufacturer.
         (3) Keep temperature of fuel containers stabilized.
         (4) Secure fuel containers from overturning.
         (5) Operate equipment away from combustible materials.
         (6) Provide adequate fire extinguishers.
   3. Existing Building:
      a. Where practicable and unless otherwise specified, existing facilities may be used, at the Owner's expense, to maintain minimum heating and cooling requirements. Normal setback temperature patterns shall not be interfered with except as specifically required to meet construction requirements. The existing system shall be protected by the Contractor from contamination, construction dust and debris. Filters shall be maintained in a clean condition and replaced with new filters at the completion of construction.
   4. Specific heating requirements, unless otherwise specified by industry or manufacturer specifications, include but are not limited to:
      a. Gypsum Plaster – Uniform minimum temperature of 55 deg F for a week before application of plaster, during plastering operations, and until plaster is dry.
      b. Gypsum Board - 55 degrees F minimum day and night during entire joint treatment operation and until execution of Certificate of Substantial Completion.
      c. Ceramic Tile - 50 deg F minimum during preparation of mortar bed, laying of the tile, and for 72 hours after completion of the tile work.
      d. Acoustical Tile - 70 deg F minimum during setting of the tile.
      e. Resilient Flooring - 70 deg F minimum during application.
      f. Painting - 55 deg F minimum during painting operations and until dry.
   5. When temporary heating, cooling, or ventilating is no longer required, the Contractor shall dismantle the temporary system and remove it at his own expense. The Contractor shall return permanent mechanical equipment to 'like-new' condition for the Substantial Completion Inspection. All warranties will begin at substantial completion regardless of when the equipment was started.

D. TEMPORARY WATER
   1. The Owner will allow the Contractor usage of existing water facilities required for construction, at the Contractor’s expense. If additional water is needed which cannot be supplied by existing facilities, the Contractor is to pay for installation of all valves, piping and metering, and arrange with the proper authority for connection of the additional water. BYU will provide the meter and contractor will install.

E. TEMPORARY SANITARY FACILITIES
   1. The Contractor shall provide and maintain sanitary, temporary toilets.
   2. The Contractor shall at all times maintain such facilities clean, neat and sanitary.
   3. Temporary outside toilets shall be removed at completion of the job.

F. SCAFFOLDING AND PLATFORMS
1. The Contractor or his subcontractors shall furnish and maintain all equipment such as temporary stairs, ladders, ramps, platforms, scaffolds, hoists, runways, derricks, chutes, elevators, etc., as required for proper execution of the Work.

2. All apparatus, equipment, and construction shall meet all requirements of labor laws, safety regulations and other applicable Federal, State or local laws.

3. Temporary stairs shall be built whenever needed. The Contractor shall provide temporary treads, handrails and shaft protection as needed or as required by governing codes.

H. TREE & PLANT PROTECTION
1. Before commencing site work, the Owner shall build and maintain protective fencing around existing trees and vegetation as identified on the Project drawings.
   a. Individual trees shall have protective fencing built beyond the drip line and to the satisfaction of the Project Manager.
   b. Groups of trees and other vegetation shall have protective fencing built around the entire group to the satisfaction of the Project Manager.
   c. Areas within protective fencing shall remain undisturbed and shall not be used for any purpose.

2. The Contractor shall protect all other trees, shrubs, lawns and all landscape work from damage and shall provide appropriate guards and covering. If normal sprinkling system is disrupted, the Contractor shall coordinate with BYU grounds to make sure the trees are watered by BYU or the Contractor.

3. Vegetation designated on drawings to be protected that has died or has been damaged beyond repair shall be removed and replaced by the Owner and back charged to the Contractor.

I. TEMPORARY ENCLOSURES
1. When walls and roof are in place, the Contractor shall provide temporary, weather tight enclosures for all exterior openings to protect all work. Openings into existing structure shall be made weatherproof.

J. PROTECTION FROM SNOW & ICE
1. The Contractor shall remove all snow and ice as may be required for the proper safety, protection and execution of the Work.

K. BRACING, SHORING, & SHEATHING
1. The Contractor shall design, furnish, install, and maintain all shoring, bracing, and sheathing as required for safety and proper execution of the Work and have the same removed if required when the Work is completed.

L. PROTECTION OF PERSONS
1. The Contractor shall provide, install, and maintain all necessary precautions to protect all persons on the site, including the public. Such measures shall include:
   a. Posting of appropriate warning signs in hazardous areas.
   b. Providing guardrails, fencing and barricades of adequate heights around all openings in floors or roofs, and around all excavations. All guardrails shall meet all applicable codes.
   c. Providing warning lights around obstructions, pits, trenches, or similar areas on-site or in adjacent streets, roads, sidewalks, or in the structure itself.
   d. When use or storage of hazardous materials or equipment is necessary for the execution of the Work, the Contractor shall exercise the utmost care and shall carry on such activities under the supervision of properly qualified personnel, and shall perform the work in accordance with all applicable codes or regulations.

M. PROTECTION FROM WEATHER
1. The Contractor shall provide protection against weather and protect all work, materials, apparatus, and fixtures. At the end of the day all work that might be damaged shall be covered.
2. If low temperatures or other weather conditions make it impossible to continue operations safely in spite of precautions, the Contractor shall cease work and notify the Project Manager.

N. PROTECTION OF EXISTING WORK
1. The Contractor shall protect all streets, private roads, and sidewalks, including overhead protection where required, and shall make all necessary repairs to damaged Work at his own expense.
2. The Contractor shall provide proper protection of all existing Work, furnishings, and fixtures likely to be damaged. When exterior openings are made in existing Work, they shall be covered with weather tight protection at the end of the day.
3. Before commencing work, the Contractor shall survey the site, and shall photograph and note any damage to existing structures including walks, curbs and utilities and shall provide copies of the photographs to the Project Manager before proceeding with work. Any damage not noted by the Contractor will be repaired or replaced by the Contractor.
4. Any Work damaged by failure to provide protection shall be removed and replaced at Contractor's expense.

O. FIRE PROTECTION
1. The Contractor shall provide at least one approved fire extinguisher in plain sight on each floor at each usable stairway prior to introduction of any combustible materials into the building.
2. Fires shall not be built on the premises.
3. In existing buildings with fire alarm/detection devices, the Contractor shall cover all smoke detectors within the work area each morning before work begins and remove dust covers at the end of the day. Fire detection devices must be functioning in the work area when the Contractor is not on the site.

P. PROTECTION OF ADJACENT PROPERTY
1. The Contractor shall provide all necessary protection and support of adjacent property.

Q. CONSTRUCTION CLEANING
1. The Contractor shall keep premises broom clean during progress of the work.
2. The Contractor shall remove waste materials and rubbish left by employees, subcontractors, and material suppliers. Roads inside and outside the Project shall be cleaned daily when hauling.
3. Before and during painting and varnishing, the Contractor shall clear the area of all debris, rubbish, and building materials that may cause dust. Sweep floors as required and take all possible steps to keep area dust free.

R. SURFACE WATER CONTROL
1. The Contractor shall protect the excavation, trenches and building from water damage by:
   a. Providing pumps, equipment and enclosures necessary for such protection.
   b. Constructing and maintaining temporary drainage and pumping as necessary to keep the site free of water.
2. The cost of water control shall be borne by the Contractor. The Owner may, if promptly notified of adverse underground water conditions, negotiate reasonable financial relief for the Contractor where such conditions could not have been learned from the Soils Engineer's Report, the Contract, or by commonly known local conditions.

S. OFFICES
1. The Contractor shall provide and maintain a weather tight office at the construction site. This building is to be located outside of, and detached from, the building under construction. Connection of utilities and monthly utility costs shall be paid by the Contractor. This building shall be the property of the Contractor and shall be removed upon completion of the Project.

T. SHEDS AND TRAILERS
The Contractor shall provide and maintain neat, weather-tight storage sheds or trailers for storage of all materials that might be damaged or affected by weather or moisture. These sheds or trailers shall
have wood floors raised above the ground and will be outside of and detached from the building under construction. They shall be property of the Contractor and shall be removed upon completion of the work.

U. CODE OF CONDUCT
Contractor recognizes that BYU is an affiliate of the Church of Jesus Christ of Latter-day Saints, and that students and employees at BYU expect to work and learn in an environment consistent with the principles of the Church. Contractor agrees that all of Contractor’s employees will A) Refrain from consuming alcohol, tobacco, or other illegal drugs on BYU campus, except that smoking may be permitted in designated, outdoor, areas; B) Refrain from using profanity; C) Observe modest standards of dress and behavior; D) be courteous and respectful to all members of the BYU campus community. Violations of these expectations may be grounds for terminating the Contractor’s engagement or for asking the Contractor to dismiss a particular, offending employee from the Project.

SECTION 21 - TESTING

A. Testing companies will be selected by the Owner.

B. The Owner and/or the Architect reserve the right to have tests taken at any time.

C. Tests not specified as part of a trade section shall be paid by the Owner.

D. Should tests reveal a failure of the Work to meet Contract requirements, subsequent tests related to the failure shall be paid by the Contractor.

E. Tests shall be made according to recognized standards by a competent, independent testing laboratory.

F. Materials found defective or not in conformance with the Contract shall be promptly replaced or repaired at the expense of the Contractor.

G. Samples required for testing shall be furnished by the Contractor and selected as directed by the Architect or Project Manager.

SECTION 22 - EXISTING UTILITIES

A. Prior to execution of the Work the Contractor is to locate all existing vaults, manholes, valves, meters, etc. Contractor is to photograph, GPS, measure from existing structures and facilities that are to remain and keep this information readily available at the site/construction trailer. Contractor is also to mark the above utilities by staking and maintaining stakes for fast and accurate locating of all existing utilities in case of emergencies.

B. BYU will initially provide all on campus blue staking information. It is the Contractor’s responsibility to maintain the blue staking locations and information by staking, painting, keeping GPS coordinates or any alternative ways that the Contractor can keep current, accurate information.

SECTION 23 - CUTTING AND PATCHING

A. The Contractor shall coordinate all cutting, fitting, or patching of the Work (including but not limited to cutting or patching of floorings; ceilings; roofs; walls; mechanical, electrical and plumbing; and all other surfaces and structures) that may be required to make the several parts of the Work come together properly. The Contractor shall coordinate all portions of the Work so as to receive or to be received by other portions of the Work, whether previously existing or newly created. The Contractor shall make proper repair or
closure of the Work as needed or as directed by the Architect or the Project Manager.

B. The Contractor shall refrain from cutting or digging in a manner that is harmful to the Owner’s premises. Contractor agrees that Contractor will not cut or alter any section of the Owner’s premises except as indicated on the plans and specifications without prior consent of the Architect and the Project Manager. The Contractor shall give 48-hour Blue Stake notice to the Project Manager and local Blue Stakes location center.

C. In the event that Contractor shall cause damage to the Owner’s premises while cutting or digging, Contractor shall cause the damage to be repaired at the Contractor’s expense.

D. All concrete slabs whether suspended or on-grade shall be scanned by the general contractor and/or verified by BYU before demoing, drilling, coring or cutting. It is the responsibility of the general contractor to repair or replace the slab, its reinforcements and other parts, utilities in the slab and adjacent surfaces as a result of failure to scan the slab.

SECTION 24 - CONDEMNATION OF WORK

A. The Owner or the Architect shall have the right to condemn and require removal of the following at the Contractor’s expense:
   1. Any portions of the Work that do not meet the requirements of the Contract either in substance or installation.
   2. Any portions of the work damaged or rendered unsuitable during installation or resulting from the Contractor’s failure to properly protect the work.

SECTION 25 - CHANGES IN THE WORK

A. The Owner may make changes within the general scope of the Contract, including but not limited to changes:
   1. In the Contract.
   2. In the method or manner of performance of the Work.
   3. In the Owner-furnished facilities, equipment, materials, or site.
   4. In directing acceleration of the Work.

B. Any written order from the Owner or Architect which changes the scope of the work shall be a Change Order.

C. The Architect is authorized to order minor changes during the Work that will not involve significant extra cost or time. The price of such minor changes will be mutually agreed upon between the Project Manager and the Contractor. The Contractor will proceed with the changed work immediately. These minor field changes will subsequently be included in a Change Order.

D. Proposal Requests may be issued which ask the Contractor to submit a price for proposed changes in the scope of the Work. The Contractor is to promptly provide costs associated with the prospective changes, including credits for deleting any unnecessary Work. Cost breakdowns are to be submitted in sufficient detail to verify that the complete scope of the Work is understood by the Contractor, Architect, and Project Manager.

E. Change Orders -
   1. Except for emergencies as covered in Section 8, and to avoid delays, no changes in the work shall be made without a written Change Order. The Contractor's proposal shall be the basis of negotiation for the Change Order price and/or time adjustments.
   2. If the Owner decides it is necessary to proceed with changed work to avoid delay before prices or times have been negotiated, he may order the Contractor to proceed on a time and materials basis or on a mutually agreed not-to-exceed price and time extension. This notice to proceed shall be issued by the Owner's Representative. Upon receipt of such order, the Contractor shall immediately perform the changed work. The Owner and the Contractor will then negotiate the price and/or time when practicable, and a Change Order will be issued.
3. When submitting proposals for Change Orders, the Contractor shall furnish a price breakdown itemizing costs as required by the Owner. Unless otherwise directed, the breakdown shall be in sufficient detail to allow an analysis of all material, labor, equipment, overhead costs and profit, and shall cover all Work involved in the change, whether such Work was deleted or added. Any amount claimed for subcontractors shall be supported by a similar price breakdown. In addition, if the proposal includes a time extension, a justification shall be furnished. The proposal, with the price breakdown and time extension justification, shall be furnished within fourteen (14) days of the date that the first request was made by the Owner's Representative. In such proposals, profit and overhead shall be computed as follows:

a. The Subcontractor's profit and overhead shall not exceed 15% of total direct costs.
b. The Contractor's profit and overhead on work done by his own crews shall not exceed 15% of total direct costs.
c. The Contractor's profit and overhead on work performed by subcontractors shall not exceed 5% of total direct costs or in the case of a CMGC Contract the Contractor’s profit and overhead fee on change orders shall not exceed the pre-contract negotiated fee.
d. The subcontractor’s profit and overhead on work performed by any of his subcontractors shall not exceed 5% of total direct costs. Contractor's profit and overhead will not exceed 5% of total direct costs.
e. On credit changes, profit and overhead on the originally estimated work will not have to be returned to the Owner.
f. No supervision costs, office managerial costs, or office expenses can be added to Change Orders.
g. Upon signing a Change Order, the Contractor releases the Owner from any further claim for money or time because of the changed work.

SECTION 26 - CLAIMS FOR EXTRA COST

A. If the Contractor intends to assert any additional claim for equitable adjustment of cost or time, he must, within fourteen (14) calendar days of the events or circumstances giving rise to the change, submit to the Architect and the Owner a written statement of the nature and monetary extent of such claim. If a mutually acceptable settlement of the claim cannot be reached within a reasonable time, the parties to the Contract shall handle the matter as a dispute under Section 27 "DISPUTES."

SECTION 27 - DELAYS AND EXTENSION OF TIME

A. All time limits stated in the Contract are of the essence. Contractor agrees to carry out the Work according to the time durations and limits as specified in the Contract.

B. If the Contractor is delayed any time during the progress of the work because of labor disputes, abnormal weather, unusual delays in transportation, or any other causes beyond the Contractor's control, the Contractor may be given additional time to complete the work by Change Order.

1. All requests for time extensions shall be made in writing to the Project Manager.
   a. Claims for time extension due to abnormal weather shall be made within fourteen (14) days of the abnormal weather.
   b. Claims made beyond these time limits shall not be considered by the Owner.
2. Requests for time extensions shall be fully documented by including copies of daily logs, letters, shipping orders, delivery tickets and other supporting information.
3. In case of a continuing cause of delay only one claim is necessary.

SECTION 28 - DISPUTES

A. Except as otherwise provided in the Contract, any dispute concerning a question of fact arising under this Contract that is not disposed of by agreement shall be decided by the Owner's Representative (as represented by the Assistant Administrative Vice President/Physical Facilities of Brigham Young University). The decision shall be rendered in writing and mailed or otherwise given to the Contractor. If
the decision is not agreeable to the Contractor, the Contractor will, within fourteen (14) days of the decision, mail or otherwise furnish to the Owner's Representative a written appeal addressed to the Owner.

SECTION 29 - CORRECTION & WARRANTY OF WORK

A. The Contractor shall promptly correct any work that fails to conform to the requirements of the Contract during the progress of the Work. The Contractor shall remedy any defects due to faulty materials, equipment or construction that appear within one year from substantial completion of the Contract or within such longer periods as may be prescribed by law or by the terms of any applicable extended guarantee required by the Contract. The Contractor shall promptly correct all faulty work or pay all costs of correcting the faulty work.

SECTION 30 - OWNER'S RIGHT TO DO WORK

A. If the Contractor defaults or neglects to carry out the Work according to the Contract or fails to perform any provision of the Contract, the Owner may, upon approval of the Architect, after providing seven days written notice to the Contractor and without prejudice to any other remedy Owner may have, make good such deficiencies. In such case, an appropriate Change Order will be issued deducting the cost of correcting such deficiencies, including the cost of the Architect's additional services made necessary by such default, neglect or failure. If the payments due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

SECTION 31 - CONTRACTOR'S PAY REQUEST

A. The Contractor shall submit to the Project Manager a monthly payment request based on the estimated value of the work completed and materials on the site as of that date. The payment request shall be on the form provided in this document, or on the then-current AIA G702 Application and Certification for Payment (or equivalent) Form. Such payment request shall be based on the schedule of values submitted by the Contractor. The Contractor warrants that title to all work, materials and equipment covered by the payment request, whether incorporated in the Project or not, will pass to the Owner upon the receipt of such payment by the Contractor, free and clear of all liens, claims, security interests or encumbrances. The Project Manager may audit Contractor payments to subcontractors or suppliers anytime.

SECTION 32 - PAYMENTS TO CONTRACTOR

A. Upon approval of the Contractor's monthly payment request, the Owner will, within fourteen (14) days after receipt of said certification, mail to the Contractor a sum equal to 95% of the amount requested, less previous payment thereon. The retention that is withheld by the Owner will be placed in an interest-bearing account and paid to the Contractor after the project is completed and accepted by the Owner.

B. Upon receipt of a payment by the Owner, the Contractor shall pay each subcontractor within fourteen (14) calendar days, the amount allowed to the Contractor for the subcontractor's work.

C. The Contractor's monthly payment request, which shall show the amount paid under the subcontract, shall be made available to the Project Manager for examination. Full and final payment of the Contract amount shall be made within thirty (30) days of the completion of the following requirements:

1. The Architect's and Owner's written acceptance of the work.
2. Payment of all labor and material bills, and receipt of all final lien waivers or lien releases from all subcontractors, mechanics and suppliers.
3. No payment made under this Contract shall be construed to be an acceptance of defective or improper materials or construction.

D. A schedule of dollar values shall be submitted to the Architect and the Owner before the Contractor’s first
E. The schedule of values shall be submitted on the Owner's standard payment request form.
   1. This breakdown shall follow the trade divisions of the specification. Each item shall include its pro
      rata part of overhead and profit so that the sum of the items will equal the Contract price.
   2. The breakdown will correspond exactly to items of work in the Project schedule including work of
      subcontractors.
F. The Contractor shall make arrangements to receive all payments from the Owner by direct deposit.

SECTION 33 - PAYMENTS WITHHELD

A. Payments may be withheld from the Contractor by the Owner to protect the Owner from loss due to:
   1. Defective work not remedied.
   2. Liens or claims filed or reasonable evidence of probable filing.
   3. The Contractor's failure to promptly pay subcontractors for labor and materials accepted by the
      Contractor.
   4. The Architect's or the Project Manager's reasonable doubt that the Project can be completed for the
      unpaid balance of the Contract price.
   5. Damage to another contractor.
   6. Failure to maintain scheduled progress.

B. Upon satisfactory correction of the above conditions, withheld payments will be made.

SECTION 34 - CONTRACTOR RESPONSIBILITIES

A. The Contractor is fully responsible for the Project and all materials and work until the Owner has accepted
   the completed Project in writing. The Contractor shall replace or repair, at his own expense, any materials
   or work damaged or stolen even if the Contractor has received payment for the work or materials.

B. By executing the Contract, the Contractor represents that he has visited the site, familiarized himself with
   the local conditions under which the Work is to be performed, and correlated his observations with the
   requirements of the Contract.

C. The Contractor shall employ a competent superintendent satisfactory to the Architect and the Owner. The
   superintendent shall be present at the Project site during the progress of the Work. This superintendent shall
   not be changed except with the prior consent of the Project Manager or unless the superintendent ceases to
   be in the Contractor's employment. The replacement superintendent shall also be subject to these
   conditions. The superintendent shall represent the Contractor, and all communications given to the
   superintendent shall be as binding as if given to the Contractor.

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

E. In the event that the Contractor receives purported directions regarding the Work from anyone other than
   the Project Manager, the Contractor shall forward/direct all communications to the Project Manager.

F. Unless otherwise directed, the Contractor shall, within two (2) hours after the bid opening, furnish the
   Architect and the Owner a list of the proposed subcontractors who will be working on the Project. The
   Owner will notify the Contractor in writing if any of the subcontractors are unacceptable.

G. The Contractor shall not contract with any subcontractor who has been rejected by the Owner or the
   Architect. The Contractor will not be required to contract with any subcontractor, person or organization
against whom he has a reasonable objection if such objection is made before the bid opening. The Contractor is not to use or accept any bid from a subcontractor unless the Contractor is willing and able to work with that subcontractor.

H. If the Owner or the Architect requires a change of any proposed subcontractor or person or organization previously accepted by them, the Contract amount shall be increased or decreased by the difference in cost occasioned by such change and an appropriate Change Order shall be issued.

I. The Contractor shall not make any substitution of a subcontractor who has been accepted by the Owner and the Architect unless the substitution is accepted in writing by the Owner and the Architect. Any increase in cost shall be paid by the Contractor.

J. All damage or loss to any property caused in whole or in part by the Contractor, any subcontractor, or by either of their agents, shall be remedied by the Contractor at no cost to the Owner.

K. The Contractor shall be solely responsible for initiating and supervising all safety programs including, but not limited to:
   1. The protection of all persons on the site, including the public.
   2. All conditions specified in this contract.
   3. All conditions required by codes and/or governmental regulations including OSHA.
   4. The protection of all property on the site or affected by the Work.
   5. The Contractor shall designate a responsible member of its organization at the site whose duty will be the prevention of accidents. This person will be Contractor’s onsite representative unless otherwise designated in writing by Contractor to Owner and Architect.

L. The Contractor shall be responsible for:
   1. Limiting all Work at the site to Monday through Saturday, between the hours of 7:00 A.M. to 10:00 P.M. No Sunday work is to be performed. Any exceptions to the working hours or days must be made by prior written authorization by the Owner.
   2. Requiring all personnel on site to be appropriately dressed. This includes protective clothing and equipment as needed. Shirts are to be worn at all times.
   3. Limiting all Work at the site according to local noise ordinances or other ordinances.

M. The Contractor’s employees shall not be allowed to use radios, boomboxes, etc., are on the site.

N. Renderings representing the Work are the property of the Owner. All photographs of the Work, whether taken during construction or at completion, are the property of the Owner. The Owner reserves all rights including copyrights to renderings and photographs of the Work. Buildings shall not be photographed, and no renderings or photographs shall be taken, obtained, used, or distributed without the prior written consent of the Owner.

O. All information regarding the cost of the Project shall be considered confidential and shall not be disclosed by the Contractor to any third party without the prior written consent of the Owner.

SECTION 35 - SUBCONTRACTORS

A. The Contractor's responsibility for this Project includes the work of all subcontractors and material suppliers, including those recommended or approved by the Owner. The Contractor shall be held responsible to the Owner for proper completion and guarantee of all construction and materials under subcontracts and for the acts and omissions of his subcontractors or their employees. Any warranties required for such work shall be obtained by the Contractor in favor of the Owner and delivered to the Owner. It is expressly agreed that there is no contractual relationship between the Owner and any subcontractor, and under no circumstances shall the Owner be responsible for the nonperformance or financial failure of any subcontractor.
B. The Contractor shall require each subcontractor to agree:
   1. To be bound by terms of the Contract as far as applicable to the subcontractor’s work.
   2. To assume toward the Contractor the same obligations the Contractor has assumed toward the Owner, including the prompt payment of his employees and material suppliers affected by this work.
   3. To submit his applications for payment to the Contractor in time to allow the Contractor to make timely application to the Owner.
   4. To execute claim or lien releases or lien waivers as requested by the Contractor for payments made by the Contractor.
   5. To make all claims for extra work or for extensions of time to the Contractor in the same manner the Contractor is to make this type of claim to the Owner.

C. The Contractor agrees in his relationship with the subcontractors:
   1. To bind himself to the subcontractors by all the obligations that the Owner assumes to the Contractor.
   2. To pay the subcontractors within fourteen (14) calendar days upon receipt of payment from the Owner that portion of the funds received as represents the subcontractor’s portion of the Work completed to the Contractor’s satisfaction for which payment was made by the Owner.

SECTION 36 - LOCKOUT/TAGOUT, CONFINED SPACE, HAZARD COMMUNICATION PROGRAMS, HOT WORK and EXCAVATION PERMIT PROGRAMS

A. The Contractor and the subcontractors will have a written "Lockout/Tagout" program. A copy of this program will be submitted to the Project Manager.

B. The Contractor and subcontractors shall evaluate all work places to determine if any spaces are permit-required confined spaces in accordance with any applicable OSHA regulations. If the workplace contains permit spaces, the Contractor shall inform exposed employees by posting danger signs in compliance with OSHA regulations. If the Contractor decides that its employees will enter permit spaces, the Contractor shall implement a written confined space program. The written program shall be made available to all persons (whether employees of the Contractor or not) and submitted to the Project Manager. The confined space program shall inform the persons that the workplace contains confined spaces that require a permit to enter those spaces. The Contractor shall identify the hazards that may be encountered in the confined space. The Contractor shall specify any precautions or procedures required for the protection of persons in or near confined spaces.

C. Besides complying with the confined space requirements that apply to all employers, the Contractor shall:
   1. Obtain any available information regarding permit space hazards and entry operations.
   2. Coordinate entry operations when both contractor and subcontractor personnel will be working in or near permit spaces.

D. The Contractor shall inform the Project Manager of the methods the Contractor will use to inform all employees on the site of any precautionary measures that need to be taken for protection during the workplace's normal and emergency operating conditions. The Contractor will specify the methods to inform the employees of the labeling system for hazardous materials. The Contractor may rely on an existing hazard communication program to comply with these requirements if it is current with OSHA regulations.

E. The Contractor shall make the written hazard communication program available to all personnel working on the Project and to the Project Manager.

H. In addition to the Hot Work permit required under Section 14, above, the Contractor shall have and implement a Hot Work permitting program that complies with all OSHA regulations. This program must be
communicated to all those who might be involved with Hot Work. Copies of this program shall be made available to the Project Manager upon request.

I. The Contractor shall have and implement a written excavation permitting program that complies with all OSHA regulations. This program must be communicated to all those who might be involved with related work. Pre-task planning and job hazards must be assessed prior to any excavations on the Project. Existing utilities must be identified and procedures put in place to avoid damage or interruptions to existing buildings or operations. Copies of this program shall be made available to the Project Manager upon request.

SECTION 37  -  OWNER'S RIGHT TO CANCEL CONTRACT

A. The Contractor shall give the Owner at least twenty-one (21) days written notice before filing any petition for bankruptcy. The Contractor shall be in material breach of the Contract if the Contractor fails to give this notice.

B. Should the Contractor make a general assignment for the benefit of his creditors, or if he should persistently refuse or fail to apply enough properly-skilled workers or proper materials to correctly execute the Work, or if he should fail to make prompt payment to the subcontractors or material suppliers for accepted material or labor, or constantly disregard laws, ordinances or instructions of the Architect and the Owner, or otherwise be guilty of substantial violation of any provision of the Contract, then the Owner may, without any prejudice to any other right or remedy and after giving the Contractor seven (7) days written notice, terminate employment of the Contractor and take possession of the premises and all materials, tools and appliances, and finish the Work by whatever method the Owner deems expedient. In such case, the Contractor shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract price exceeds the expense of finishing the Work, including compensation for additional administrative services, such excess shall be paid to the Contractor. If such expense shall exceed the unpaid balance, the Contractor shall pay the difference to the Owner.

SECTION 38  -  CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE CONTRACT

A. If the Work should be stopped under court order, or other public authority for thirty (30) days, or the Owner shall fail to pay the Contractor within thirty (30) days of receipt of a properly prepared and completed payment request, then the Contractor may, on seven (7) days written notice to the Owner and the Architect, terminate this Contract and recover from the Owner the percentage of the Contract price represented by the work completed as of the date of termination with any loss sustained which can be established.

SECTION 39  -  SEPARATE CONTRACTS

A. The Owner reserves the right to award separate contracts concerning other portions of the Project under these or similar conditions of the Contract to other contractors.

B. The Contractor shall afford separate contractors reasonable opportunity for the introduction and storage of their materials and equipment and the execution of their work, and shall properly connect and coordinate his work with theirs.

C. If any part of the Contractor's work depends upon the work of another separate contractor, the Contractor shall inspect and promptly report to the Project Manager any apparent discrepancies or defects in such work that render it unsuitable for proper execution and results. Failure of the Contractor to inspect the work is an acceptance of the work of the separate contractor unless defects develop in the other separate contractor's work after the execution of the Contractor's work.

SECTION 40  -  ASSIGNMENT
A. The Contractor shall not assign or sublet this Contract or any part of it or any monies due him without prior written consent of the Owner.

SECTION 41 - LIQUIDATED DAMAGES

A. For each calendar day that the Work or any portion of the Work remains incomplete after the expiration of the time limit set in the Contract or by Change Order, the amount per calendar day shown in the Supplementary Conditions will be deducted from the money due or to become due to the Contractor. This deduction is not a penalty, but is liquidated damages and may include additional expenses such as administrative and inspection costs.

B. At the time of substantial completion, and after the meeting to certify substantial completion, the Owner, Architect and Contractor shall agree upon the time that will be allowed for the Contractor to complete the remaining Work on the Project. If the Contractor does not complete the Work within the agreed time, the liquidated damages will continue at a reduced amount as stated in the Supplementary Conditions. The liquidated damages shall be in full force and effect, not as a penalty but as liquidated damages for each additional calendar day it takes to complete the Project. If liquidated damages are required, they shall be accrued and deducted from the money due the Contractor.

SECTION 42 - ACCELERATION OF WORK

A. If, in the judgment of the Architect or the Owner, it becomes necessary at any time to accelerate the Work or part of it, the Contractor shall deploy the workers in such portions of the Project to enable others to properly engage and carry on their work. If circumstances require that the entire Work or a portion of it be completed at a date earlier than the Contract completion date as adjusted by Change Orders, the Contractor shall increase his forces, equipment, hours of work, or number of shifts, and shall speed delivery of materials to meet the altered completion date or dates ordered or directed. Any increase in cost to the Contractor according to such orders or directives will be adjusted by Change Order.

B. If the Work is behind schedule and the rate of placement of work is inadequate to regain scheduled progress, the Contractor shall immediately take action to ensure timely completion of the Work.

1. This shall be accomplished by any one or a combination of the following or others suitable measures:
   a. An increase in working forces.
   b. An increase in equipment or tools.
   c. An increase in hours of work or number of shifts.
   d. Expediting delivery of materials.

2. The Contractor shall notify the Project Manager of specific measures taken or planned to increase the rate of progress with an estimate of when scheduled progress will be regained.

3. Acceleration of work will continue until scheduled progress is regained. Scheduled progress shall be established from the latest revised and approved Project schedule for the job.

4. Timely completion will be understood as the Contract completion date as revised by all time extensions.

5. The Contractor shall not be entitled to additional compensation for efforts to regain scheduled progress.

SECTION 43 - CONTRACTOR'S QUALITY CONTROL

A. MATERIAL QUALITY

1. Materials incorporated into the Project shall be new except as otherwise indicated in the specifications. Materials shall be of specified quality and furnished in sufficient quantity to simplify proper and timely execution of the Work.

2. The Contractor shall furnish evidence of the quality of materials incorporated into the Project as
required by the Contract or at request of the Architect or the Project Manager.
3. Materials not meeting requirements of the Contract shall be removed from the Project and replaced with materials meeting the Contract requirements by the Contractor at no additional expense to the Owner.

B. ASBESTOS
1. The Contract has been prepared following generally accepted professional architectural and engineering practices. Accordingly, no asbestos or products containing asbestos have been knowingly specified for this Project. The Contractor agrees to notify the Project Manager immediately for instructions if:
   a. Materials containing asbestos are brought to the site for inclusion in the Work.
   b. Asbestos materials are encountered in any existing structures upon which work is being done.
2. At the Architect's direction and with the Owner's approval, an independent testing laboratory will perform testing procedures on suspect materials at Owner’s expense.
3. The Contractor shall certify, based upon his best knowledge, information, inspection and belief, that no building materials containing asbestos were used in the construction of the Project. The Contractor will submit certification on form provided by the Owner.

SECTION 44 - TEMPORARY OR TRIAL USAGE OF ANY MECHANICAL DEVICES

A. Temporary or trial usage by the Owner of mechanical devices, machinery, apparatus, elevators, equipment or other work or materials supplied under this Contract before written acceptance by the Owner shall not be construed as evidence of the Owner's acceptance.

SECTION 45 - PROJECT CLOSEOUT

A. FINAL CLEANING
1. Upon completion of the Work, the Contractor shall remove all tools, scaffolding, surplus materials and all rubbish from under and about the building. The Contractor shall leave the building clean and habitable, having thoroughly swept or vacuumed floors, cleaned windows and dusted flat surfaces such as cabinet tops and window sills.
2. Besides general cleaning noted above, the Contractor shall do the following special cleaning for all trades at the completion of the work:
   a. Remove putty or caulking stains from glass. Wash and polish inside and outside, exercising care not to scratch glass.
   b. Remove marks, stains, fingerprints, other soil and dirt from painted, decorated and stained work.
   c. Clean and polish woodwork.
   d. Clean and polish hardware for all trades. This shall include removal of stains, dust, dirt, paint and other similar materials.
   e. Remove spots, soil and paint. Wash tile work.
   f. Clean fixtures and equipment, and remove stains, paint, dirt and dust.
   g. Remove temporary floor protection and clean floors. Spray and buff resilient flooring.
   h. Clean exterior and interior metal surfaces, including doors and windows, required to have polished finishes. Remove oils, stains, dust, and dirt. Polish surfaces, leaving them without fingerprints or other blemishes.
3. If the Contractor fails to clean up, the Owner may do so and the cost will be withheld from the Contractor’s final payment.

B. PROJECT RECORD DOCUMENTS
The Contractor shall deliver to the Architect before the substantial completion inspection:
1. Accurate Project "record" drawings, including redline drawings.
2. Certificates of occupancy that may be required by Authorities Having Jurisdiction over the work.
C. OPERATING & MAINTENANCE DATA
Before execution of the certificate of substantial completion, the Contractor shall furnish the operating instructions and maintenance manuals as called for in the Contract.

D. WARRANTIES & GUARANTEES
1. When written guarantees beyond one year after substantial completion are required of any section of the Work, the Contractor shall secure such guarantees properly addressed and signed in favor of the Owner. These documents shall be delivered to the Project Manager upon substantial completion of the Contractor's work and before execution of the certificate of substantial completion.
2. Delivery of guarantees and warranties shall not relieve the Contractor from any obligation assumed under any other provisions of his Contract.
3. Nothing within the Contract intends or implies that guarantees shall apply to work abused or neglected by the Owner.

E. PRE-SUBSTANTIAL, SUBSTANTIAL, & FINAL COMPLETION INSPECTIONS
1. Pre-Substantial Completion Inspection:
   a. Upon the Contractor's request and if the request is accompanied by a punch list prepared by the Contractor, the Project Manager and the Architect will make inspections and furnish a list of additional items to be corrected or completed by the Contractor.
   b. The Contractor shall notify the Project Manager when items have been corrected or completed. Upon the Project Manager's verification of correction, the Project Manager will arrange a substantial completion inspection to include the Owner, Architect, engineers and college representatives.
2. Substantial Completion Inspection:
   a. At the substantial completion inspection, unless the Work is rejected, the Architect may execute a certificate of substantial completion (to be signed by the Architect, Owner and Contractor) that states the dates for:
      (1) User occupancy,
      (2) Commencement of warranties,
      (3) Final completion inspection,
      (4) Modifications to the amount assessed for liquidated damages.
   b. After inspection, the Architect will furnish a final list of items to be corrected.
   c. The Owner, Architect and Contractor will decide how much time is to be allowed for completion of the items.
3. Final Completion Inspection:
   a. Final Completion Inspection will ensure that all deficiencies noted at the substantial completion inspection have been corrected.
   b. When all items have been corrected, the Project Manager will process the final payment and send a final completion letter indicating the final completion date to the Contractor.
   c. If all items have not been corrected as agreed, the Owner may elect to complete the work under provisions of Section 29 of the General Conditions.
   d. All lien waivers and releases are to be submitted before final payment can be made.
   e. A copy of the final payment consent form will be obtained from the surety/bonding company.

SECTION 46 - OWNER- PURCHASED MATERIALS AND EQUIPMENT
A. The Owner desires to purchase certain materials which will be utilized in the Work. Contractor's duties with respect to Owner-purchased materials are:
   1. Scheduling:
a. The Contractor shall furnish the Owner with a schedule of dates on which the Contractor requires delivery of Owner-purchased materials. The Owner will arrange for the materials to be delivered to the construction site on or before the specified dates. If delivery dates are changed, rescheduled, or otherwise varied from the original schedule, the Contractor shall notify the Owner in writing of delivery date rescheduling and the Contractor shall coordinate the delivery of the Owner-purchased materials directly with the supplier.

2. Pre-Installation Inspection:

a. The Contractor shall be responsible for receiving, inspecting and storing all Owner-purchased materials until the materials are needed for installation by the Contractor. Regardless of any inspection performed by the Owner of the Owner-purchased materials, the Contractor shall be responsible for inspecting the Owner-purchased materials to determine suitability, quality and conformance with specifications before installation or at such other time as the Contractor may desire in order to avoid interruptions and delays in the progress of the Project. The Contractor shall reject any material which does not meet specifications or which appears to have any defect which may make the material unsuitable for use in the Project. The Contractor shall notify the Owner and the manufacturer or supplier of all defects and assist the Owner in arranging for the repair, replacement or correction of the defective condition. The Contractor shall not be entitled to an extension of any deadline or completion date which results from failure to discover defects which the Contractor should have discovered through an inspection.

3. Defective Materials:

a. The Contractor acknowledges that use of improper or defective material may result in costs and damages to the Owner in excess of the value of the materials; that after use in the Project it may be difficult or impossible to inspect the material to determine the cause of any failure; and that in the event of the failure of material there may be a question as to the cause of the failure. Because the Contractor's employees will be the last to handle and inspect material prior to incorporation into the Project, the Contractor will be liable to the Owner for damages resulting from failure of Owner-purchased materials during the Contractor's warranty period specified herein from any cause whatsoever unless the Contractor provides clear and convincing proof that (1) the entire loss from a failure is covered by a valid manufacturer's or supplier's warranty, or (2) the Contractor could not have prevented the failure by complying with the requirements of this Section concerning Owner-purchased materials.

4. Claims:

a. The Contractor agrees to assist the Owner to present claims to manufacturers and suppliers for defects in Owner-purchased materials. Where there is any question as to the division of liability between the Contractor and a manufacturer or vendor, the Contractor shall provide all relevant information in the Contractor's possession which may aid the Owner in determining the division of responsibility. The Owner shall have final approval of any proposed adjustment or settlement of warranty claims.

5. Implied Warranties:

The benefit of contractual and implied warranties with respect to Owner-purchased materials shall run to the Owner and not to the Contractor.

6. Unloading:

Except as otherwise provided herein, the Contractor shall be responsible for unloading all Owner-purchased materials and verifying delivery amounts to the Owner.

7. Custody and Security:

The Contractor shall use reasonable care in protecting Owner-purchased materials from loss, deterioration, damage, theft, vandalism or destruction.

8. Reports:

At Owner's request, the Contractor shall furnish reports to the Project Manager demonstrating the Contractor's compliance with this Section.

9. Retained Ownership:

All materials purchased by the Owner which remain after completion of the Project shall be the property of the Owner. If the Owner does not wish to retain or dispose of surplus Owner-purchased materials, the Contractor shall remove and dispose of them.
10. Rights of Ownership:
   None of the foregoing duties of the Contractor with respect to Owner-purchased materials shall prevent the Owner from exercising any prerogative of ownership of the materials.

SECTION 47 - OWNER'S SALES TAX EXEMPT STATUS

A. Contractor and subcontractors are authorized to purchase Construction Materials on behalf of Brigham Young University free of Utah sales tax, as defined by applicable Utah State Tax Rule. The grant of this contractual right is conditioned upon and made subject to the following:
   1. The construction materials must be installed or converted into real property owned by Brigham Young University and may not be used for any purpose other than constructing the Project.
   2. All construction materials purchased without sales tax must be clearly identified and segregated at all times between the time of purchase and time of installation into the Project.
   3. Contractor and subcontractors will comply with such instructions and guidance as Brigham Young University may issue from time to time to implement Tax Commission requirements for the sales tax exemption on construction materials.

B. Brigham Young University will provide the Contractor with the Sales Tax Exemption Certificate.

SECTION 48 – FOREIGN PRODUCTS AND CURRENCY

A. All foreign product costs shall be negotiated in U.S. dollars. Owner will not assume any risk for currency fluctuations after bidding. Contractor assumes all responsibility for any change in costs due to foreign currency fluctuations if the Contractor chooses to negotiate product costs in a foreign currency.
SUPPLEMENTARY CONDITIONS

SECTION 1--COMMENCEMENT, PROSECUTION & COMPLETION OF THE WORK

A. The Contractor shall be required to commence work after receipt of the contract from the Owner.

B. The Contractor shall prosecute the work diligently so as to complete it within the time limit allowed in this document.

C. The Contractor agrees to complete this work required by the Contract on or before midnight July 17, 2020.

D. Time is hereby expressly declared to be of the essence of the Contract.

SECTION 2--LIQUIDATED DAMAGES

A. The amount agreed upon and established as liquidated damages up to substantial completion is $300 per calendar day.

B. At the time of substantial completion the Owner and the Contractor will agree on how much time will be allowed for the Contractor to complete the remaining work. If the Contractor exceeds the time allowed, liquidated damages will continue at one third (1/3) of the amount of the original liquidated damages or $100 per calendar day.

SECTION 3--FIRE/SMOKE ALARMS

A. The Contractor shall be charged $1,000.00 for any fire alarm or smoke alarm that is caused by the Contractor and disrupts the building occupants. BYU fire alarm technicians are available to answer any questions concerning the alarm systems. The Contractor is to contact the Project Manager to coordinate alarm technicians.

SECTION 4—EXISTING UTILITIES

A. Prior to execution of the work the contractor is to locate all existing vaults, manholes, valves, meters, etc. Contractor is to photograph, GPS, measure from existing structures and facilities that are to remain and keep this information readily available at the site/construction trailer. Contractor is also to mark the above utilities by staking and maintaining stakes for fast and accurate locating of all existing utilities in case of emergencies.

B. BYU will initially provide all on campus blue staking information. It is the contractor’s responsibility to maintain the blue staking locations and information by staking, painting, keeping GPS coordinated or any alternative ways that the contractor can keep current, accurate information.

SECTION 5—CONTRACTOR WORKING HOURS

A. No work will be performed between the hours of 10:00 p.m. and 7 a.m. without prior written authorization or in case of emergency situation approved by BYU Project Manager. No work is allowed on Sunday.
SECTION 6—BUILDER’S RISK INSURANCE

Section 13 of the General Conditions is deleted in its entirety and replaced with the following:

SECTION 13—BUILDERS RISK LOSSES

A. If the Contract Sum is over $100,000, prior to performing any work, Contractor will obtain and maintain during the term of this Agreement All-Risk Builders Risk Insurance Policy – ISO Form CP 00 20 (10/12), Builders’ Risk Coverage (or equivalent) and ISO Form CP 10 30 (10/12), Causes of Loss Special Form, including coverage for flood, or equivalent insurance forms, with Limits of Insurance in the amount of the Contract Sum. An installation floater may be used, if approved in writing by Owner. The Policy will:
   a. cover materials stored at temporary storage locations and materials in transit;
   b. include Owner and all Subcontractors as additional named insureds;
   c. be subject to a deductible payable by Contractor of not less than $2,500 per occurrence of any loss, which will be the responsibility of Contractor and will not be included in the Cost of the Work or be a reimbursable expense; and
   d. provide that such insurance is primary, non-contributory and not excess coverage.

B. Contractor will provide evidence of this insurance coverage to Owner by providing, if applicable, a Certificate of Insurance on ACORD 27, Evidence of Property Insurance, for the Builder’s Risk Insurance Policy, identifying the Project as defined in the Contract, submitted to Owner, attaching the endorsement giving evidence that the Owner and all Subcontractors are listed as named insureds on the Builder’s Risk Policy.
<table>
<thead>
<tr>
<th>Date Payable To:</th>
<th>Contractor</th>
<th>Project Name</th>
<th>Project No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request No.</td>
<td>Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period From</td>
<td>City, State, Zip</td>
<td>Project No.</td>
<td></td>
</tr>
<tr>
<td>TAX ID#</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## APPLICATION FOR PAYMENT

1. **ORIGINAL CONTRACT AMOUNT**  
   $________ - 

2. **NET CHANGE BY CHANGE ORDERS**  
   $________ - 

3. **CONTRACT AMOUNT TO DATE**  
   (line 1 plus line 2)  
   $________ -  
   **Contractor's Representative**  
   ____________________________

4. **TOTAL EARNED**  
   (work completed and materials stored to date)  
   $________ -  
   **Date**  
   ____________

5. **AMOUNT THIS REQUEST**  
   $________ -  
   **Owner's Representative**  
   ____________________________

6a. **RETAIINAHE HELD THIS REQUEST**  
   (5% of line 5)  
   $________ -  
   **Date**  
   ____________

6b. **RETAINTAGE RELEASED THIS REQUEST**  
   $________ - 

6c. **RETAIINAHE RELEASED TO DATE**  
   (total of line 6b above plus previous pay app line 6c)  
   $________ - 

6d. **TOTAL HELD RETAINAGE TO DATE**  
   (5% of line 4 minus line 6c)  
   $________ -  
   **Project Manager**  
   ____________

7. **TOTAL EARNED LESS RETAINAGE HELD TO DATE**  
   (line 4 minus line 6d)  
   $________ -  
   **Date**  
   ____________

8. **LESS PREVIOUS PAYMENTS**  
   (line 7 from previous pay app)  
   $________ -  
   **Director of Construction**  
   ____________________________

9. **CURRENT PAYMENT DUE**  
   (line 7 minus line 8)  
   (to check take line 5 minus line 6a plus line 6b)  
   $________ -  
   **Director of Planning**  
   ____________________________

10. **BALANCE TO FINISH,**  
    Including Retainage  
    (line 3 minus Line 4 plus Line 6d)  
    $________ -  
    **Architect**  
    ____________________________

**Legend** data input
## SCHEDULE of VALUES

**Contractor**

<table>
<thead>
<tr>
<th>Item NO.</th>
<th>DESCRIPTION</th>
<th>Subcontractor or Supplier</th>
<th>% Item of Total</th>
<th>CONTRACT Amount</th>
<th>% THIS ESTIMATE</th>
<th>AMOUNT THIS ESTIMATE</th>
<th>% TO DATE</th>
<th>AMOUNT TO DATE</th>
<th>% of Retention</th>
<th>Retention Withheld</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTALS**
SECTION 042731
REINFORCED UNIT MASONRY

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Concrete Block.
B. Mortar and Grout.
C. Reinforcement and Anchorage.
D. Flashings.
E. Accessories.

1.02 RELATED REQUIREMENTS
A. Section 078400 - Firestopping: Firestopping at penetrations of masonry work.
B. Section 079200 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS
F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
M. ASTM C140/C140M - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units; 2017a.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ___________________________________________________________ ______________________________

1.04 SUBMITTALS
A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar and grout.
C. Shop Drawings: Indicate bar sizes, spacings, reinforcement quantities, bending and cutting schedules, reinforcement supporting and spacing devices, and accessories.
D. Samples: Submit four samples of decorative block units to illustrate color, texture, and extremes of color range.
E. Design Data: Indicate required mortar strength, unit assembly strength in each plane, and supporting test data.
F. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE
A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
   1. Maintain one copy of each document on project site.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 MOCK-UP
A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories, structural backup, reinforcement, and grout in mock-up.
B. Locate where directed.
C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.08 FIELD CONDITIONS
A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.
B. Protect all masonry work from moisture damage. Cover work as needed.
C. Maintain materials and air temperature to a minimum of 40 degrees during masonry construction work and for 48 hours after walls have been constructed.

D. Measures must be taken to prevent efflorescence. Remove and replace masonry that has effloresced at no expense to owner.

PART 2 PRODUCTS

2.01 UNIT MASONRY - GENERAL

2.02 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on drawings for specific locations.
   2. Special Shapes: Provide non-standard blocks configured for corners.
   3. Load-Bearing Units: ASTM C90, light weight.
      a. Hollow block, as indicated.
      b. Exposed Faces: Manufacturer's standard color and texture where indicated.
   4. Pre-Faced Units: ASTM C90, hollow block, with smooth resinous facing complying with ASTM C744.
      a. Colors and Styles: As indicated.

2.03 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C91/C91M Type N.

B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.

C. Hydrated Lime: ASTM C207, Type S.

D. Mortar Aggregate: ASTM C144.

E. Grout Aggregate: ASTM C404.

F. Water: Clean and potable.

2.04 REINFORCEMENT AND ANCHORAGE

A. Manufacturers:

B. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) yield strength.
   1. Deformed billet-steel bars.
   2. Unfinished.

C. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.

D. Single Wythe Joint Reinforcement: ASTM A951/A951M.
   1. Type: Truss or ladder.
   3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.

E. Multiple Wythe Joint Reinforcement: ASTM A951/A951M.
   1. Type: Truss.
   3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.

F. Single Wythe Joint Reinforcement: Truss type; ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to ASTM A153/A153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods;
width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

G. Multiple Wythe Joint Reinforcement: Truss type; ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to ASTM A153/A153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

H. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A153/A153M, Class B, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in.

2.05 FLASHINGS

A. Stainless Steel/Polymer Fabric Drainage Plane Flashing: ASTM A240/A240M; 2 mil type 304 stainless steel sheet bonded between one sheet of polymer fabric and one sheet of non-woven drainage material.

1. Manufacturers:
   a. STS Coatings, Inc; ______: www.stscoatings.com/#sle.
   b. York Manufacturing, Inc; Flash-Vent SS: www.yorkmfg.com/#sle.

B. Stainless Steel/Polymer Fabric Drainage Plane Flashing - Self-Adhering: ASTM A240/A240M; 2 mil type 304 stainless steel sheet with 8 mil of butyl adhesive and a removable release liner on one side and a sheet of non-woven drainage material bonded to the other side.

1. Manufacturers:

C. Factory-Fabricated Flashing Corners and End Dams: Stainless steel.

1. Manufacturers:

D. Pre-Coated Galvanized Steel: ASTM A653/A653M, with G90/Z275 coating, at least 24 gage, 0.0239 inch base metal thickness, shop precoated with fluoropolymer coating in color matching masonry.

E. Stainless Steel: ASTM A666, Type 304, soft temper; at least 26 gage, 0.0187 inch thick, with smooth, bright finish No. 2B.

F. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane, or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.

G. Termination Bars: Stainless steel; compatible with membrane and adhesives.

H. Drip Edge: Stainless steel; angled drip with hemmed edge; compatible with membrane and adhesives.

I. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.

2.06 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.

1. Manufacturers:
   b. Hohmann & Barnard, Inc; ______: www.h-b.com/#sle.
   c. WIRE-BOND; ______: www.wirebond.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.

B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.

C. Termination Bars: Stainless steel; compatible with membrane and adhesives.

D. Drip Edge: Stainless steel; compatible with membrane and adhesives.
E. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.
F. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.07 MORTAR MIXES
A. Ready Mixed Mortar: ASTM C1142, Type RM.
B. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
   1. Masonry below grade and in contact with earth; Type S.
   2. Exterior, loadbearing masonry; Type N.
   3. Interior, loadbearing masonry; Type N.
C. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

2.08 MORTAR MIXING
A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
B. Maintain sand uniformly damp immediately before the mixing process.
C. Do not use anti-freeze compounds to lower the freezing point of mortar.
D. If water is lost by evaporation, re-temper only within two hours of mixing.

2.09 GROUT MIXES
A. Bond Beams and Lintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.
   1. Fine grout for spaces with smallest horizontal dimension of 2 inches or less.
   2. Coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
B. Engineered Masonry: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.
   1. Fine grout for spaces with smallest horizontal dimension of 2 inches or less.
   2. Coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

2.10 GROUT MIXING
A. Mix grout in accordance with ASTM C94/C94M.
B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field conditions are acceptable and are ready to receive masonry.
B. Verify that related items provided under other sections are properly sized and located.
C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION
A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
B. Clean reinforcement of loose rust.
C. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
D. For areas where high-lift grouting will be employed, provide cleanout openings as follows:
   1. Brick Masonry: Not less than 8 inches on center at the bottom of one wythe, formed by omitting bricks.
2. Hollow Masonry: Not less than 8 inches high at the bottom of each cell to be grouted, formed by cutting out face shell of masonry unit.

3.03 COURSING
   A. Establish lines, levels, and coursing indicated. Protect from displacement.
   B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
   C. Concrete Masonry Units:
      1. Bond: Running.
      2. Coursing: One unit and one mortar joint to equal 8 inches.

3.04 PLACING AND BONDING
   A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
   B. Lay hollow masonry units with face shell bedding on head and bed joints.
   C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
   D. Remove excess mortar as work progresses.
   E. Interlock intersections and external corners, except for units laid in stack bond.
   F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
   G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
   H. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.

3.05 REINFORCEMENT AND ANCHORAGE
   A. Reinforcement Bars: Secure at locations indicated and to avoid displacement during grouting. Minimum spacing between bars or to masonry surfaces shall be one bar diameter.
   B. Joint Reinforcement: Install horizontal joint reinforcement 8 inches on center.
      1. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
      2. Place continuous joint reinforcement in first and second joint below top of walls.
      3. Lap joint reinforcement ends minimum 6 inches.
   C. Anchors: Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.
   D. Anchors: Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches horizontally and 24 inches vertically.
   E. Wall Ties: Install wall ties at locations indicated, spaced at not more than 24 inches on center horizontally and 16 inches on center vertically, unless otherwise indicated on drawings.
   F. Reinforced Brick Masonry: Maintain grout spaces indicated, free of mortar and not less than 6 inches greater than the sum of bar diameters in the grouted space. Provide temporary dams or barriers to control flow of grout at ends of wall sections; remove dams when grout has hardened sufficiently.
   G. Reinforced Hollow Unit Masonry: Keep vertical cores to be grouted clear of mortar, including bed area of first course.
      1. Bond Beams: At bond beams or other locations for horizontally reinforced masonry, provide special masonry units or saw to accommodate reinforcement.

3.06 MASONRY FLASHINGS
   A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up at least 8 inches, minimum, to form watertight pan at non-masonry construction.
2. Remove or cover protrusions or sharp edges that could puncture flashings.
3. Seal lapped ends and penetrations of flashing before covering with mortar.

B. Terminate flashing up 8 inches minimum on vertical surface of backing:
   1. Install vertical leg of flashing behind water-resistant barrier sheet over backing.

3.07 GROUTING
A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of Contract Documents.
B. Perform all grouting by means of low-lift technique. Do not employ high-lift grouting.
C. Low-Lift Grouting:
   1. Limit height of pours to 48 inches.
   2. Limit height of masonry to 16 inches above each pour.
   3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
   4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.
D. High-Lift Grouting:
   1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
   2. Clean out masonry cells and other cavities to be grouted by compressed air. Remove debris, allow to dry, and inspect before sealing cleanout openings.
   4. Hollow Masonry: Limit lifts to maximum 12 feet and pours to maximum height of 12 feet.
   5. Place grout for spanning elements in single, continuous pour.

3.08 CONTROL AND EXPANSION JOINTS
A. Do not continue horizontal joint reinforcement through control or expansion joints.
B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
C. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.

3.09 BUILT-IN WORK
A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.
B. Install built-in items plumb, level, and true to line.
C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
   1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
D. Do not build into masonry construction organic materials that are subject to deterioration.

3.10 TOLERANCES
A. Install masonry within the site tolerances found in TMS 402/602.
B. Maximum Variation from Alignment of Columns: 1/4 inch.
C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
G. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.11 CUTTING AND FITTING
A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.
B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.12 FIELD QUALITY CONTROL
A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.
C. Mortar Tests: Test each type of mortar in accordance with recommended procedures in ASTM C780, testing with same frequency as masonry samples.
D. Test and evaluate grout in accordance with ASTM C1019 procedures.
   1. Test with same frequency as specified for masonry units.
E. Prism Tests: Test masonry and mortar panels for compressive strength in accordance with ASTM C1314 and for flexural bond strength in accordance with ASTM C1072 or ASTM E518/E518M; perform tests and evaluate results.

3.13 CLEANING
A. Remove excess mortar and mortar smears as work progresses.
B. Replace defective mortar. Match adjacent work.
C. Clean soiled surfaces with cleaning solution.
D. Use non-metallic tools in cleaning operations.

3.14 PROTECTION
A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Mechanically attached system with thermoplastic roofing membrane.
   B. Insulation, flat and tapered.
   C. Vapor retarder.
   D. Deck sheathing.
   E. Flashings.
   F. Roofing stack boots, roofing expansion joints, and walkway pads.
   G. Roof pavers systems.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene one week before starting work of this section.
      1. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.04 SUBMITTALS
   A. See Section 013000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
   C. Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.
   D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   E. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.
   F. Manufacturer's Qualification Statement.
G. Installer’s Qualification Statement.
H. Warranty Documentation:
   1. Submit manufacturer warranty and ensure that forms have been completed in Owner’s name and registered with manufacturer.
   2. Submit installer’s certification that installation complies with warranty conditions for waterproof membrane.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
   B. Installer Qualifications: Company specializing in performing the work of this section with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products in manufacturer’s original containers, dry, undamaged, with seals and labels intact.
   B. Store products in weather protected environment, clear of ground and moisture.
   C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.
   D. Protect foam insulation from direct exposure to sunlight.

1.07 FIELD CONDITIONS
   A. Do not apply roofing membrane during unsuitable weather.
   B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above 120 degrees F.
   C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
   D. Do not expose materials vulnerable to water in quantities greater than can be weatherproofed the same day.
   E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.08 WARRANTY
   A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
   B. Material Warranty: Provide membrane manufacturer’s warranty agreeing to replace material that shows manufacturing defects within five years after installation.
   C. System Warranty: Provide manufacturer’s system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
      1. Warranty Term: 20 years.
      2. For repair and replacement include costs of both material and labor in warranty.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Thermoplastic Polyolefin (TPO) Membrane Roofing Materials:
   B. Thermoplastic Polyvinyl Chloride (PVC) Membrane Roofing Materials:
      1. Sika Corporation Roofing; Sarnafil PVC: usa.sarnafil.sika.com/#sle. 60 mil thickness.
2.02 ROOFING - UNBALLASTED APPLICATIONS

A. Thermoplastic Membrane Roofing: One ply membrane, mechanically fastened, over insulation.

B. Roofing Assembly Requirements:
   1. Solar Reflectance Index (SRI): Minimum of 64 based on three-year aged value; if three-year aged data is not available, minimum of 82 initial value.
      b. Field applied coating may not be used to achieve specified SRI.

C. Acceptable Insulation Types - Constant Thickness Application: Any of the types specified.
   1. Minimum 2 layers of polyisocyanurate or extruded polystyrene board.
   2. Bottom layer of polyisocyanurate or extruded polystyrene board covered with single layer of polyisocyanurate or extruded polystyrene board.

D. Acceptable Insulation Types - Tapered Application: ____________.
   1. Tapered polyisocyanurate, extruded polystyrene, or Expanded Polystyrene (EPS) board.

2.03 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

A. Membrane Roofing Materials:
   1. PVC: Polyvinyl chloride (PVC) conforming to ASTM D4434/D4434M, Type II, sheet contains reinforcing fibers or reinforcing fabrics.
      a. Thickness: 60 mil, 0.060 inch, minimum.
   2. TPO: Thermoplastic polyolefin (TPO) conforming to ASTM D6878/D6878M, sheet contains reinforcing fabrics or scrims.
      a. Thickness: 60 mil, 0.060 inch, minimum.
   3. Sheet Width: Factory fabricated into largest sheets possible.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Membrane Fasteners: As recommended and approved by membrane manufacturer.

D. Vapor Retarder: Material approved by roof manufacturer complying with requirements of fire rating classification; compatible with roofing and insulation materials. Must be a 32 mil Minimum thickness self-adhered product.
   1. Fire-retardant adhesive.

E. Flexible Flashing Material: Same material as membrane.

2.04 DECK SHEATHING AND COVER BOARDS

A. Deck Sheathing and Cover Board: Glass mat faced gypsum panels, ASTM C1177/C1177M, fire resistant type, 1/2 inch thick.
   1. Manufacturers:
      b. USG Secure Rock.

2.05 INSULATION

A. Expanded Polystyrene (EPS) Board Insulation: Complies with ASTM C578, with drainage channels on one face.
   1. Tapered Board: Slope as indicated; minimum thickness 1/2 in; fabricate of fewest layers possible.
   2. Board Edges: Square.

2.07 ACCESSORIES

A. Roofing Expansion Joint Flashing: Same as Roofing Material.

B. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ________________________________________________________________
C. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
D. Membrane Adhesive: As recommended by membrane manufacturer.
E. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
   1. Composition: Roofing membrane manufacturer’s standard.
   2. Size: As indicated.
   3. Surface Color: White
   4. Manufacturers:
      a. Same as Roofing Manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.
B. Verify deck is supported and secure.
C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
D. Verify deck surfaces are dry and free of snow or ice.
E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.04 INSTALLATION - GENERAL

A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.
B. Do not apply roofing membrane during unsuitable weather.
C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.05 VAPOR RETARDER AND INSULATION - UNDER MEMBRANE

A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
   1. Extend vapor retarder under cant strips and blocking to deck edge.
   2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.
C. Attachment of Insulation:
   1. Mechanically fasten insulation to deck in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.
D. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.
E. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
F. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
G. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
H. Do not apply more insulation than can be covered with membrane in same day.
3.06 MEMBRANE APPLICATION
   A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
   B. Shingle joints on sloped substrate in direction of drainage.
   C. Overlap edges and ends and seal seams by heat welding, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
   D. Mechanical Attachment: Apply membrane and mechanical attachment devices in accordance with manufacturer's instructions.
   E. At intersections with vertical surfaces:
      1. Extend membrane up a minimum of 6 inches onto vertical surfaces.
      2. Fully adhere flexible flashing over membrane and up to nailing strips.
   F. Around roof penetrations, seal flanges and flashings with flexible flashing.
   G. Install roofing expansion joints where indicated. Make joints watertight.
   H. Coordinate installation of roof drains and sumps and related flashings.

3.07 CLEANING
   A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.
   B. Remove bituminous markings from finished surfaces.
   C. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
   D. Repair or replace defaced or damaged finishes caused by work of this section.

3.08 PROTECTION
   A. Protect installed roofing and flashings from construction operations.
   B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Non-fire-rated hollow metal doors and frames.
   B. Hollow metal frames for wood doors.
   C. Fire-rated hollow metal doors and frames.
   D. Thermally insulated hollow metal doors with frames.
   E. Sound-rated hollow metal doors and frames.
   F. Hollow metal borrowed lites glazing frames.
   G. Accessories, including glazing, louvers, and matching panels.

1.02 RELATED REQUIREMENTS
   A. Section 087100 - Door Hardware.
   B. Section 088000 - Glazing: Glass for doors and borrowed lites.
   C. Section 099113 - Exterior Painting: Field painting.
   D. Section 099123 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS
   B. ASCE - American Society of Civil Engineers.
   C. HMMA - Hollow Metal Manufacturers Association.
   D. NAAMM - National Association of Architectural Metal Manufacturers.
   F. SDI - Steel Door Institute.
   G. UL - Underwriters Laboratories.

1.04 REFERENCE STANDARDS
   B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors,
      Frames and Frame Anchors; 2011.
   C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2014.
   D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for
      Steel Doors and Frames; 2011.
   E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron
      Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
   F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural,
      High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and
      Bake Hardenable; 2016.
   G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon,
      Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-
      High Strength; 2015.
   H. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission
      Loss of Building Partitions and Elements; 2009 (Reapproved 2016).
   I. ASTM E413 - Classification for Rating Sound Insulation; 2016.
N. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2016.
Q. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.05 SUBMITTALS
A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
D. Manufacturer's Qualification Statement.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
C. Maintain at project site copies of reference standards relating to installation of products specified.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Hollow Metal Doors and Frames:
   2. Curries, an Assa Abloy Group company; www.assaabloydss.com/#sle.
   4. All hardware locations to be per CECO standard locations.

2.02 DESIGN CRITERIA
A. Requirements for Hollow Metal Doors and Frames:
   1. Steel used for fabrication of doors and frames shall comply with one or more of the following requirements: Galvanized steel conforming to ASTM A653/A653M, cold-rolled steel conforming to ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel conforming to ASTM A1011/A1011M, Commercial Steel (CS) Type B for each.
   2. Accessibility: Comply with ICC A117.1 and ADA Standards.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020
Signature & Date: ______________________________________  _______________________________
3. Door Edge Profile: Manufacturers standard for application indicated.
5. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
   a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.

B. Hollow Metal Panels: Same construction, performance, and finish as doors.

C. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS
A. Door Finish: Architect to confirm finish with BYU.
B. Exterior Doors: Thermally insulated.
   1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
      a. Level 3 - Extra Heavy-duty.
      b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 16 gage, 0.053 inch, minimum.
      e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
   2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
   4. Weatherstripping: Refer to Section 087100.

2.04 HOLLOW METAL FRAMES
A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
B. Frame Finish: Same as hollow metal door.
C. Exterior Door Frames: Face welded type.
   1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
   2. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
   3. Weatherstripping: Separate, see Section 087100.
D. Interior Door Frames, Non-Fire Rated: Face welded type.
   1. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
   2. Knock-down door frames are allowed in remodeling applications but not in new construction.
E. Door Frames, Fire-Rated: Face welded type.
   1. Fire Rating: Same as door, labeled.
   2. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
F. Sound-Rated Door Frames: Face welded type.
   1. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
G. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
H. Mullions for Pairs of Doors: Fixed, except where removable is indicated, with profile similar to jambs.
I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.         Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  _______________________________

BYU STANDARD SPECIFICATION 2018 REV 1.0

081113 - 4 HOLLOW METAL DOORS AND FRAMES

I. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

J. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inch high to fill opening without cutting masonry units.

K. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

L. Frames Installed Back-to-Back: Reinforce with steel channels anchored to floor and overhead structure.

2.05 FINISHES
A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES
A. Glazing: As specified in Section 088000, factory installed.
B. Astragals for Double Doors: Specified in Section 087100.
C. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
D. Grout for Frames: Portland cement grout with maximum 4 inch slump for hand troweling; thinner pumpable grout is prohibited.
E. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
F. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that opening sizes and tolerances are acceptable.
C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION
A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
B. Install fire rated units in accordance with NFPA 80.
C. Coordinate frame anchor placement with wall construction.
D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
E. Install door hardware as specified in Section 087100.
F. Comply with glazing installation requirements of Section 088000.
G. Coordinate installation of electrical connections to electrical hardware items.
H. Touch up damaged factory finishes in accordance with the painting sections of this specification.

3.03 TOLERANCES
A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.04 ADJUSTING
A. Adjust for smooth and balanced door movement.
B. Adjust sound control doors so that seals are fully engaged when door is closed.
C. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.05 SCHEDULE
A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION
SECTION 087100
DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hardware for solid core wood, aluminum, and hollow metal doors.
B. Hardware for fire-rated doors.
C. Electrically operated and controlled hardware.
D. Thresholds.
E. Weatherstripping and gasketing.
F. Note: Lock cylinders are furnished and installed by Owner (NIC)

1.02 PROJECT INFORMATION

A. The architect must work with the following hardware consultant: ASSA ABLOY DSS - Steve Carter (385) 228-3541 steve.carter@assaabloy.com or another person approved by the BYU Access Services Shop Manager (801) 422-5499.
B. The hardware must be coordinated through the BYU Access Services Shop: Lamar Howarth (801) 422-5499 or current shop manager and the BYU Construction PM assigned to this project.

1.03 RELATED REQUIREMENTS

A. Section 062000 - Finish Carpentry: Wood door frames.
B. Section 079200 - Joint Sealants: Sealants for setting exterior door thresholds.
C. Section 080671 - Door Hardware Schedule: Schedule of door hardware sets.
D. Section 081113 - Hollow Metal Doors and Frames.
E. Section 081116 - Aluminum Doors and Frames.
F. Section 081416 - Flush Wood Doors.
G. Section 081700 - Integrated Door Opening Assemblies.
H. Section 083323 - Overhead Coiling Doors: Door hardware, except cylinders.
I. Section 083326 - Overhead Coiling Grilles: Door hardware, except cylinders.
J. Section 083613 - Sectional Doors: Door hardware, except cylinders.
K. Section 084313 - Aluminum-Framed Storefronts: Door hardware, except as noted in section.
L. Section 084413 - Glazed Aluminum Curtain Walls: Door hardware, except cylinders.
M. Section 084426 - Structural Glass Curtain Walls: Door hardware, except cylinders.
N. Section 281000 - Access Control: Electronic access control devices.
O. Section 284600 - Fire Detection and Alarm: Electrical connection to activate door closers.

1.04 REFERENCE STANDARDS

B. BHMA (CPD) - Certified Products Directory; 2017.
E. BHMA A156.3 - American National Standard for Exit Devices; 2014.
F. BHMA A156.4 - American National Standard for Door Controls - Closers; 2013.
G. BHMA A156.6 - American National Standard for Architectural Door Trim; 2015.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  _______________________________
I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.  

Signature & Date: ______________________________________  _______________________________

BYU STANDARD SPECIFICATION 2018 REV 1.0  

I. BHMA A156.8 - American National Standard for Door Controls - Overhead Stops and Holders; 2015.
L. BHMA A156.16 - American National Standard for Auxiliary Hardware; 2013.
M. BHMA A156.18 - American National Standard for Materials and Finishes; 2016.
N. BHMA A156.21 - American National Standard for Thresholds; 2014.
R. BHMA A156.36 - American National Standard for Auxiliary Hardware; 2016.
S. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames; 2016.
T. BHMA A156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames; 2006.
U. DHI (H&S) - Sequence and Format for the Hardware Schedule; 1996.
V. DHI (KSN) - Keying Systems and Nomenclature; 1989.
X. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
AA. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2016.
AC. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
AD. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
C. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; attendance is required by affected installers and the following:
   1. Architect.
   2. Owner's Door Opening Consultant (ASSA ABLOY Steve Carter)
   3. Hardware Supplier.
   4. Hardware Installer.
   5. Owner's Security Consultant.
   6. BYU Access Services - Lamar Howarth.
   7. BYU Construction Project Manager.
D. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
1.06 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.

C. Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
   1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
   2. Conform to DHI (H&S) using door numbers and hardware set numbers as indicated in construction documents.
      a. Submit in vertical format, refer to Section 080671.
   3. List groups and suffixes in proper sequence.
   4. Provide complete description for each door listed.
   5. Provide manufacturer's and product names, and catalog numbers; include functions, types, styles, sizes and finishes of each item.
   6. Include account of abbreviations and symbols used in schedule.

D. Shop Drawings - Electrified Door Hardware: Submit diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
   1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
   2. Elevations: Submit front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
   3. Diagrams: Submit point-to-point wiring diagram that shows each device in door opening system with related colored wire connections to each device.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

F. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
   1. Submit manufacturer's parts lists and templates.

G. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

H. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.

C. Supplier Qualifications: Company with certified Architectural Hardware Consultant (AHC) to assist in work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
B. Warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion.
1. Closers: Three Years, minimum.
2. Exit Devices: Three years, minimum.
3. Locksets and Cylinders: Three years, minimum.
4. Other Hardware: Two years, minimum.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.

B. Provide individual items of single type, of same model, and by same manufacturer.

C. Provide door hardware products that comply with the following requirements:
   1. Applicable provisions of federal, state, and local codes.
   4. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
   5. Hardware on Fire-Rated Doors: Listed and classified by UL (DIR) or testing firm acceptable to authorities having jurisdiction as suitable for application indicated.
   6. Hardware for Smoke and Draft Control Doors (Indicated as "S" on Drawings): Provide door hardware that complies with local codes, and requirements of assemblies tested in accordance with UL 1784.
      a. Air Leakage Rate: Tested in accordance with UL 1784, with air leakage rate not to exceed 3.0 cfm/sf of door opening at 0.10 inch of water for both ambient and elevated temperature tests.
   7. Listed and certified compliant with specified standards by BHMA (CPD).
   8. Auxiliary Hardware: BHMA A156.16.
  10. Hardware Preparation for Wood Doors with Wood or Steel Frames: BHMA A156.115W.
  11. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.

D. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.
   1. Refer to Section 281000 for additional access control system requirements.

E. Lock Function: Provide lock and latch function numbers and descriptions of manufacturer's series. Refer to Section 080671 for listing of hardware sets.

F. Fasteners:
   1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
      a. Aluminum fasteners are not permitted.
      b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
   2. Provide machine screws for attachment to reinforced hollow metal and aluminum frames.
      a. Self-drilling (Tek) type screws are not permitted.
   3. Provide stainless steel machine screws and lead expansion shields for concrete and masonry substrates.
   4. Provide wall grip inserts for hollow wall construction. Provide backing for all hardware in stud walls.
   5. Fire-Rated Applications: Comply with NFPA 80.
a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.
b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.

2.02 Hinges

A. Manufacturers:
5. Substitutions: See Section 016000 - Product Requirements.

B. Hinges: Complying with BHMA A156.1, Grade 1.
1. Butt Hinges: Complying with BHMA A156.1 and BHMA A156.7 for templated hinges.
   a. Provide hinge width required to clear surrounding trim.
3. Provide hinges on every swinging door.
4. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
5. Provide ball-bearing hinges at each door.
6. Provide non-removable pins on exterior outswinging doors.
7. Provide non-removable pins on interior outswinging doors at locations as indicated in Door Hardware Schedule.
8. Provide power transfer hinges where electrified hardware is mounted in door leaf.
9. Provide following quantity of butt hinges for each door:
   a. Doors From 60 inches High up to 90 inches High:  Three hinges.
   b. Doors 90 inches High up to 120 inches High:  Four hinges.
   c. Doors From 42 inches wide up to 48 inches Wide:  Four hinges.
   d. Doors over 120 inches High:  One additional hinge per each additional 30 inches in height.
   e. Dutch Doors:  Two hinges each leaf.

2.03 Flush Bolts

A. Manufacturers:
2. Ives, an Allegion brand; _____:  www.allegion.com/us/#sle.

B. Flush Bolts: Complying with BHMA A156.16, Grade 1.
2. Provides extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
   a. Pairs of Swing Doors:  At inactive leaves, provide flush bolts of type as required to comply with code.
3. Provide dustproof floor strike for bolt into floor, except at metal thresholds.
5. Self-Latching Flush Bolts: Automatically latch upon closing of door; manually retracted; located on inactive leaf of pair of doors.

2.06 Lock Cylinders Not in Contract - By Owner

A. Manufacturers:
1. Basis of Design: ASSA Twin 6000. Provided and installed by BYU Access Services

2.07 Cylindrical Lockset

A. Manufacturers:

B. Cylindrical Lockset (Bored): Complying with BHMA A156.2, Grade 1, 4000 Series.
   1. Bored Hole: 2-1/8 inch diameter.
   2. Latchbolt Throw: 1/2 inch, minimum.
   4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
      a. Finish: To match lock or latch.
      b. Extra-Long-Lip Strikes: Provide for locks used on frames with applied wood casing trim.

2.15 PROTECTION PLATES
A. Manufacturers:
   2. Ives, an Allegion brand; _____: www.allegion.com/us/#sle.

B. Protection Plates: Complying with BHMA A156.6.
C. Metal Properties: Stainless steel.
   1. Metal, Standard Duty: Thickness 0.05 inch, minimum.

D. Edges: Beveled, on four sides unless otherwise indicated.
E. Fasteners: Countersunk screw fasteners.

2.16 ARMOR PLATES (VERIFY LOCATIONS WITH OWNER)
A. Manufacturers:
   1. Rockwood; an Assa Abloy Group company; [K1050]: www.assaabloydss.com
   2. Ives, an Allegion brand; _____: www.allegion.com/us/#sle.

B. Armor Plates: Provide on bottom half of push side of doors that require protection from objects moving through openings that may damage door surface.
   1. Size: 16 inch high by 1-1/2 inch less door width (LDW) on pull side and 2 inch LDW on push side of door.

2.17 KICK PLATES
A. Manufacturers:
   1. Rockwood; an Assa Abloy Group company; [K1050]: www.assaabloydss.com
   2. Ives, an Allegion brand; _____: www.allegion.com/us/#sle.

B. Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
   1. Size: 10 inch high by 2 inch less door width (LDW) on push side of door.

2.21 FLOOR STOPS
A. Manufacturers:
   1. Rockwood; an Assa Abloy Group company; 441H: www.assaabloydss.com
   2. Substitutions: See Section 016000 - Product Requirements.

B. Floor Stops: Complying with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
   1. Provide floor stops when wall surface is not available; be cautious not to create a tripping hazard.

2.24 THRESHOLDS
A. Manufacturers:
   1. Pemko; an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.
B. Thresholds: Complying with BHMA A156.21.
1. Provide threshold at each exterior door, unless otherwise indicated.
2. Type: Flat surface.
4. Threshold Surface: Fluted horizontal grooves across full width.
5. Field cut threshold to profile of frame and width of door sill for tight fit.
6. Provide non-corroding fasteners at exterior locations.

2.25 WEATHERSTRIPPING AND GASKETING

A. Manufacturers:
1. Pemko; an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Weatherstripping and Gasketing: Complying with BHMA A156.22.
1. Head and Jamb Type: Self-adhesive.
2. Door Sweep Type: Encased in retainer.
3. Material: Aluminum, with brush weatherstripping.
4. Provide gasketing for smoke and draft control doors (Indicated as "S" on Drawings) that complies with local codes, requirements of assemblies tested in accordance with UL 1784.
5. Provide frame-applied intumescent gasketing on wood doors that are labeled as smoke and draft control doors (Indicated as "S" on Drawings), unless otherwise indicated.
6. Provide weatherstripping on each exterior door at head, jambs, and meeting stiles of door pairs, unless otherwise indicated.
7. Provide door bottom sweep on each exterior door, unless otherwise indicated.
8. Provide sound-rated gasketing and automatic door bottom on doors indicated as "Sound-Rated", "Acoustical", or with "Sound Transmission Class (STC) rating"; fabricate as continuous gasketing, do not cut or notch gasketing material.

2.26 LATCH PROTECTOR

A. Manufacturers:
1. Rockwood; an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.

B. Latch Protector: Provide on door to protect latch from being tampered with while in locked position.
1. Type: Standard latch protector.

2.32 FINISHES

A. Finishes: Provide door hardware of same finish, unless otherwise indicated.
1. Primary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.
2. Exceptions:
   a. Where base material metal is specified to be different, provide finish that is an equivalent appearance in accordance with BHMA A156.18.
   c. Door Closer Covers and Arms: Color as selected by Architect from manufacturer's standard colors unless otherwise indicated.
   d. Hardware for Aluminum Storefront Doors: Finished to match door panel finish, except at hand contact surfaces provide stainless steel with satin finish, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.

B. Verify that electric power is available to power operated devices and of correct characteristics.
3.02 INSTALLATION
A. Install hardware in accordance with manufacturer's instructions and applicable codes.
B. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
C. Install hardware for smoke and draft control doors in accordance with NFPA 105.
D. Use templates provided by hardware item manufacturer.
E. Do not install surface mounted items until application of finishes to substrate are fully completed.
F. All hardware mounting to be per CECO locations.
G. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

3.03 FIELD QUALITY CONTROL
A. Perform field inspection and testing under provisions of Section 014000 - Quality Requirements.
B. Provide an Architectural Hardware Consultant (AHC) to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.04 ADJUSTING
A. Adjust work under provisions of Section 017000 - Execution and Closeout Requirements.
B. Adjust hardware for smooth operation.
C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING
A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
B. Clean adjacent surfaces soiled by hardware installation.
C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.06 PROTECTION
A. Protect finished Work under provisions of Section 017000 - Execution and Closeout Requirements.
B. Do not permit adjacent work to damage hardware or finish.

END OF SECTION
SECTION 099723
CONCRETE AND MASONRY COATINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Moisture resistant textured concrete and masonry coatings.
B. Moisture resistant smooth concrete and masonry coatings.

1.02 RELATED REQUIREMENTS
A. Section 099113 - Exterior Painting.

1.03 REFERENCE STANDARDS
M. SSPC-SP 2 - Hand Tool Cleaning; 1982 (Ed. 2004).
N. SSPC-SP 3 - Power Tool Cleaning; 1982 (Ed. 2004).
O. SSPC-SP 6 - Commercial Blast Cleaning; 2007.
P. SSPC-SP 7 - Brush-Off Blast Cleaning; 2007.

1.04 SUBMITTALS
A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating coating materials.
C. Samples: Submit two samples 12 by 12 inch in size illustrating colors available for selection.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
F. Maintenance Data: Include cleaning procedures and repair and patching techniques.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  ______________________________
1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this
      section with minimum five years documented experience.
   B. Applicator Qualifications: Company specializing in performing the work of this section with minimum
      Three years documented experience.

1.06 MOCK-UP
   A. Provide mock-up of coating products, 4 feet long by 4 feet wide, illustrating coating, color, and surface
      sheen, for each specified coating.
   B. Locate where directed.
   C. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS
   A. Do not install materials when temperature is below 55 degrees F or above 90 degrees F.
   B. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
   C. Provide lighting level of 80 ft candles measured mid-height at substrate surface.
   D. Restrict traffic from area where coating is being applied or is curing.

1.08 WARRANTY
   A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a five year period after Date of Substantial Completion.
   C. Warranty: Include coverage for bond to substrate and degradation of chemical resistance.

PART 2  PRODUCTS

2.01 MANUFACTURERS

2.02 CONCRETE AND MASONRY COATINGS
   A. Provide high-build, weather resistant coating systems that meet the following minimum performance
      criteria, unless more stringent criteria are specified:
      1. Salt Spray Resistance: Passes when tested according to ASTM B117 for 2000 hours.
      2. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0, maximum, when
         tested in accordance with ASTM E84.
      3. Accelerated Outdoor Exposure: Passes when tested according to ASTM G153 for 5,000 hours.

2.03 MATERIALS
   A. Coatings - General: Provide complete systems formulated and recommended by manufacturer for the
      applications indicated, in the thicknesses indicated.
      1. Maximum volatile organic compound (VOC) content: As required by applicable regulations.
   B. not used
   C. High Build, Water Based Textured Coating System for Masonry: Water based styrene-acrylic resin
      primer; acrylic terpolymer (elastomeric) top coat and graded perlite aggregate.
      1. Stated by manufacturer as suitable for masonry and concrete surfaces cured 28 days, minimum;
         cement plaster, cement fiber board, and metal.
      2. Dry Film Thickness: 15 mils, minimum.
      3. Flexibility Test: Passing, when tested according to ASTM D522/D522M with a 1 inch mandrel.
      4. Freeze Thaw Resistance: Passing, when tested according to ASTM D2243 for 50 cycles.
      5. Water Vapor Transmission: 4.2 perms, maximum, when tested in accordance with ASTM
         E96/E96M.
      6. Color: To be selected by Architect from manufacturer's standard range.
      7. Texture: To be selected by Architect from manufacturer's standard range.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in
accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  _______________________________

BYU STANDARD 099723 - 2 CONCRETE AND MASONRY
SPECIFICATION 2018 REV 1.0 COATINGS
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer.
      Obtain and follow manufacturer's instructions for examination and testing of substrates.
   C. Cementitious Substrates: Do not begin application until substrate has cured 28 days minimum and measured moisture content is not greater than 16 percent.

3.02 PREPARATION
   A. Clean surfaces of loose foreign matter.
   B. Remove substances that would bleed through finished coatings.
   C. Remove finish hardware, fixture covers, and accessories and store.
   D. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.03 PRIMING
   A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.
   B. Concrete and Masonry: Prior to priming, patch holes and indentations and fill cracks with manufacturer's recommended crack repair material.

3.04 COATING APPLICATION
   A. Apply coatings in accordance with manufacturer's instructions, to thicknesses specified.
   B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.05 CLEANING
   A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
   B. Clean surfaces immediately of overspray, splatter, and excess material.
   C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION
   A. Protect finished work from damage.

END OF SECTION
SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Clearing and protection of vegetation.
B. Removal of existing debris.
C. Removal of existing utilities and built elements.

1.02 RELATED REQUIREMENTS
A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.
B. Section 011000 - Summary: Sequencing and staging requirements.
C. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
D. Section 015713 - Temporary Erosion and Sediment Control.
E. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.
F. Section 017419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
G. Section 024100 - Demolition: Removal of built elements and utilities.
H. Section 026500 - Underground Storage Tank Removal.
I. Section 312200 - Grading: Topsoil removal.
J. Section 312200 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.
K. Section 312323 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.
L. Section 329300 - Plants: Relocation of existing trees, shrubs, and other plants.
M. Section 329300 - Plants: Pruning of existing trees to remain.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SITE CLEARING
A. Cleared materials shall become Contractor's property and shall be removed from Project site unless otherwise specified.
B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways as required by authorities having jurisdiction.
C. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner prior to award of Contract. Do not proceed with work on adjoining property until directed by Owner.
D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.
E. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.         Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  _______________________________
F. Satisfactory Top Soil Materials: If satisfactory top soil materials are encountered on site, as determined by Owner's representative in the field, these materials will be hauled to 2350 North Freedom Boulevard for stockpiling. All roots trash and other such materials will be completely removed from top soil materials delivered to the BYU Stockpile Site.

G. Obtain approved borrow soil materials off-site if granular borrow material is required on site to smooth the final surface after site clearing. Refer to Section 312323 Fill for satisfactory backfill material requirements.

H. Site Preparation: All surface vegetation, topsoils, non-engineered fills, and any other deleterious materials must be removed from areas extending five feet beyond the perimeter of all buildings, pavements, and other structurally loaded areas. Stripped vegetation and other deleterious materials should be removed from the site. The depth of the stripping shall be determined on site. Trees and tree roots will be completely removed where they have been designated for removal.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Protect existing structures and other elements that are not to be removed.

E. Protect and maintain benchmarks and survey control points from disturbance during construction.

F. Notify Blue Stakes for locating all utilities. Dial 811. Calls must be placed 48-hours prior to any site work.

G. Do not interrupt utilities serving facilities occupied by others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to the requirements indicated:
   1. Notify Engineer not less than seven days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer's written permission.

H. Excavate for and remove underground utilities indicated to be removed. Backfill removal where necessary with structural fill under building, pavement, or other structurally loaded areas.

3.03 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.

B. Do not begin clearing until vegetation to be relocated has been removed.

C. Do not remove or damage vegetation beyond the limits indicated on drawings.
   1. Exception: Specific trees and vegetation indicated on drawings to be removed.

D. Work closely with BYU Construction PM and BYU Grounds Department to identify vegetation removal limits. Install substantial, highly visible fences at least 3-feet high to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
   3. Around other vegetation to remain within vegetation removal limits.
   4. See Section 015000 for fence construction requirements.

E. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Sod to be salvaged: BYU Grounds Department will identify and cut sod areas before site work begins.
   2. Sod to be disposed: Sod to be disposed of at the BYU Material Handling Area (MHA) will need to have Roundup® applied by BYU Grounds 7 days before removal. Coordinate with BYU Construction P.M. for Roundup® application.
3. Tree Relocation: Coordinate with BYU Construction PM and BYU Grounds for tree relocation.
4. Tree Disposal: Tree stumps and roots will be completely removed where they have been designated for removal and disposed of at a legal construction and demolition landfill. Tree and Shrub materials removed from the site will be cut into eight foot maximum lengths and delivered to BYU MHA site located at approximately 2350 North Freedom Boulevard.
5. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations. Owner/BYU Grounds will replace vegetation at the expense of the Contractor.

3.04 DEBRIS

A. Remove debris, junk, and trash from site.
B. Leave site in clean condition, ready for subsequent work.
C. Clean up spillage and wind-blown debris from public and private lands.

3.05 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
D. Refer to Section 015713 - Temporary Erosion and Sediment Control for additional requirements.

END OF SECTION
I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  _______________________________

BYU STANDARD SPECIFICATION 2018 REV 1.0 311000 - 4 SITE CLEARING
SECTION 312316
EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Excavating for building volume below grade, footings, slabs-on-grade, paving, site structures, and utilities within the building.
B. Trenching for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS
A. Section 015713 - Temporary Erosion and Sediment Control: Slope protection and erosion control.
B. Section 210553 - Identification for Fire Suppression Piping and Equipment: Underground warning tapes at underground fire suppression lines.
C. Section 220553 - Identification for Plumbing Piping and Equipment: Underground warning tapes at underground plumbing lines.
D. Section 230553 - Identification for HVAC Piping and Equipment: Underground warning tapes at underground HVAC lines.
E. Section 260553 - Identification for Electrical Systems: Underground warning tapes at underground electrical lines.
F. Section 311000 - Site Clearing: Vegetation and existing debris removal.
G. Section 312200 - Grading: Grading.
H. Section 312316.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
I. Section 312323 - Fill: Fill materials, filling, and compacting.

1.03 DEFINITIONS
A. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by BYU Construction PM. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
   3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by BYU Construction PM. Unauthorized excavation shall be without additional compensation.
B. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

1.04 PRICE AND PAYMENT PROCEDURES
A. See Section 012200 - Unit Prices, for general requirements applicable to unit prices for excavation.

1.05 REFERENCE STANDARDS

1.06 QUALITY ASSURANCE
A. Temporary Support and Excavation Protection Plan:
   1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
   2. Include drawings and calculations for bracing and shoring.
   3. Bracing and shoring design to meet requirements of OSHA’s Excavation Standard, 29 CFR 1926, Subpart P.
B. Pre-excavation Conference to be held at Project site.

1.07 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by BYU Construction PM and then only after arranging to provide temporary utility services according to the requirements indicated.
   1. Notify BYU Construction PM not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without BYU Construction PM's written permission.
   3. Contact Blue Stakes for Project location prior to excavation.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 PRODUCTS

2.01 MATERIALS

A. Underground Warning Tapes:
   1. See Section for 210553 underground warning tapes at underground fire suppression lines.
   2. See Section for 220553 underground warning tapes at underground plumbing lines.
   3. See Section for 230553 underground warning tapes at underground HVAC lines.
   4. See Section for 260553 underground warning tapes at underground electrical lines.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.
B. See Section 311000 for clearing, grubbing, and removal of existing debris.
C. See Section 312200 for topsoil removal.
D. Locate, identify, and protect utilities that remain and protect from damage.
E. Notify Blue Stakes for locating all utilities. Dial 811. Calls must be placed 48-hours prior to any site work.
F. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, and utilities from excavating equipment, vehicular traffic, and from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
G. Protect plants, lawns, and other features to remain.
H. Prepare existing site for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface in accordance with Section 311000 - Site Clearing.
I. Protect and maintain erosion and sedimentation controls during excavation as specified in Section 311000 - Site Clearing.
J. Provide protective insulating materials to protect constructable subgrades and foundation soils against freezing temperatures or frost.
K. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed.

3.03 EXCAVATING

A. Underpin adjacent structures that could be damaged by excavating work. Provide shoring as required by contract documents. Refer to Section 314000 Shoring.
B. Excavate to accommodate new structures and construction operations.
1. Excavate to the specified elevations.
2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
3. Cut utility trenches wide enough to allow inspection of installed utilities.
4. See Section 312316.26 for required excavation clearances for pipes in utility trenches.

C. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

D. Notify BYU Construction PM of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

E. Slope banks of excavations as per OSHA requirements.

F. Do not interfere with 45 degree bearing splay of foundations.

G. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323 Fill.

H. Provide temporary means and methods, as required, to remove all water from excavations.

I. Determine the prevailing groundwater level prior to excavation. If proposed excavation extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps or as directed by BYU Construction PM. If proposed excavation extends more than 1 foot into the excavation, control groundwater intrusion with comprehensive dewatering procedures as directed by BYU Construction PM.

J. The use of explosives is NOT permitted.

K. Remove excavated material that is unsuitable for re-use from site.

L. Remove excess excavated material from site.

M. Remove obstructions and vegetation to permit installation of new construction. Refer to Section 311000 Site Clearing for material disposal instructions.

N. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

O. All surface vegetation, topsoils, non-engineered fills, and any other deleterious materials must be removed from areas extending five feet beyond the perimeters of all proposed buildings, pavements, and other structurally loaded areas.

P. Stripped vegetation and other deleterious materials should be removed from the site. The depth of the stripping shall be determined at the site. Trees and tree roots will be completely removed where they have been designated for removal.

Q. Satisfactory topsoil materials should be salvaged to Owner in accordance with Section 311000 Site Clearing.

R. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspection.

S. Excavation for Footings and Foundations (Including Site Utility Tunnels): Interior footings of the building footprint may have loose silty sand or gravelly materials that will need to be removed from below the footings. Over-excavate loose silty sand or gravelly materials found on site under footings and backfill with structural fill up to the bottom of footing. The external footings that extend to frost depth should extend through these loose materials and should not require over-excavation. All excavations should extend a minimum of 2 feet beyond the footing perimeter. Review the bottom of excavation with BYU Construction PM prior to backfilling with structural fill or placing of concrete. The upper 8 inches of the granular soil subgrade at the base of footing excavations will be scarified, moisture conditioned to within 2% of optimum, and compacted to 92% maximum laboratory density as

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  _______________________________
determined by ASTM D1557. Trim bottoms to required lines and grades to leave solid base to receive other work. All structural fill backfill for excavations or over-excavations to meet material and compaction specifications as outlined in Section 323323 Fill.

T. Excavation for Underground Basins and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces except to compact subgrade to 95% maximum laboratory density as determined by ASTM D1557 or the percentage as indicated on plans. All utility system structures shall have a minimum of 8" compacted bedding or base course under the bottom of the structure.

U. Excavation for Walks and Pavements: Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrade. The upper 8 inches of the subgrade granular soil excavations will be scarified, moisture conditioned to within 2% of optimum, and compacted to 95% maximum laboratory density as determined by ASTM D1557. Excavate any surface clay layers encountered one foot below subgrade level and replace with one foot of 3" minus granular fill. Compact replacement granular fill to 92% of the maximum laboratory density as determined by ASTM D1557.

V. Excavation for Utility Trenches: Refer to Section 312316.13 - Trenching.

W. Notify BYU Construction PM when excavations have reached required subgrade for subgrade inspection.

1. If BYU Construction PM determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

2. Scarify the top 8 inches of subgrade under new pavements and compact to 95% of the maximum dry unit weight according to ASTM D1557.

3. Proof-roll subgrade below building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

   a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

   b. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

   c. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by BYU Construction PM, and replace with compacted backfill or fill as directed.

4. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

5. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by BYU Construction PM, without additional compensation.

X. Unauthorized Excavation: Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by BYU Construction PM. Fill unauthorized excavations under other construction or utility pipe as directed by BYU Construction PM.

Y. Storage of soil materials: Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpile to drain surface water. Cover to prevent windblown dust. Stockpile soil materials away from edge of excavations. Do not store within drip line of trees to remain.

3.04 FILLING AND BACKFILLING

A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.

B. Install underground warning tape at buried utilities according to Sections 210553, 220553, 230553, and 260553.

C. See Section 312323 for fill, backfill, and compaction requirements.
D. See Section 312316.13 for fill, backfill, and compaction requirements at utility trenches.
E. See Section 312200 for rough and final grading and topsoil replacement requirements.

3.05 REPAIR
A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312232.

3.06 FIELD QUALITY CONTROL
A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

3.07 CLEANING
A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 312200.
B. Remove excavated material that is unsuitable for re-use from site.
C. Remove excess excavated material from site.

3.08 PROTECTION
A. Divert surface flow from rains or water discharges from the excavation. Prevent surface water and groundwater from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.
D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
E. Keep excavations free of standing water and completely free of water during concrete placement. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

END OF SECTION
I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: Tuesday, January 14, 2020

Signature & Date: ______________________________________  ______________________________

BYU STANDARD  
SPECIFICATION 2018 REV 1.0  
312316 - 6  
EXCAVATION
MECHANICAL BID BREAKDOWN FORM

The General Contract bid will be tabulated using the Column “A-Base Bid” total along with all other mechanical work. (All other items, not specifically listed on this form are to be bid as specified, as listed on the Drawings, or as approved in the Addendum to the contract documents.) Prices shall be as quoted to the Contractor by the vendor excluding sales tax.

The General Contractor with the apparent low bid will provide this form complete, to the Owner, within 2 hours after the bid opening. The Mechanical Contractor’s bid must include all items in all columns listed on this form. Prices shall be verified by a copy of the quotation on request.

Vendors not specifically pre-listed under alternate Columns B, C, D, and E or “other” on this form may be submitted as a substitute by the Contractor for consideration by the Owner following procedures noted in the specification. If a column does not have a vendor pre-listed and a substitute has been pre-approved, the Mechanical Contractor may indicate the vendor providing the price in the “other” column. Mechanical items not specifically listed on this form, in the Specifications, on the Drawings or as approved in the Addendum to the contract documents, should not be listed on the Mechanical Bid Breakdown.

The Owner is not obligated to use items in Column “A-Base Bid”. The Owner reserves the right to pick and choose from among alternative offerings in Columns B, C, D, and E. The contract shall be adjusted without markup for any price differential between the price listed in Column “A-Base Bid” and that listed in any selected alternative column. The Owner reserves the right to accept or reject any of the Equipment or System items anytime within (90) ninety days after signing a contract.

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification Section</th>
<th>Base Bid “A”</th>
<th>“B”</th>
<th>“C”</th>
<th>“D”</th>
<th>“E”</th>
<th>“Other”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>230593 – TAB Contractor</td>
<td>Payson Sheet</td>
<td>BTC Service</td>
<td>Certified T&amp;B</td>
<td>RS Analysis</td>
<td>T&amp;B Inc.</td>
<td>$________</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>2</td>
<td>230810 – Variable Frequency Drives</td>
<td>ABB</td>
<td>Mitsubishi</td>
<td></td>
<td></td>
<td></td>
<td>$________</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
</tbody>
</table>

MECHANICAL BID BREAKDOWN FORM - 1
<table>
<thead>
<tr>
<th>Item</th>
<th>Specification Section</th>
<th>Base Bid “A”</th>
<th>“B”</th>
<th>“C”</th>
<th>“D”</th>
<th>“E”</th>
<th>“Other”</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>230900 – Controls Installer</td>
<td>D&amp;L Electric</td>
<td>BCS</td>
<td>Colt Controls</td>
<td>SAC</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>4</td>
<td>232114 – Air Separators</td>
<td>Bell &amp; Gossett</td>
<td>Armstrong</td>
<td>Taco</td>
<td>Amtrol</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>5</td>
<td>232114 – Expansion Tanks</td>
<td>Bell &amp; Gossett</td>
<td>Amtrol</td>
<td>Taco</td>
<td>Wheatley</td>
<td>Armstrong</td>
<td>$________</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>6</td>
<td>232123 – Hydronic Pumps</td>
<td>Bell &amp; Gossett</td>
<td>Armstrong</td>
<td>Taco</td>
<td>Patterson</td>
<td>Grundfos</td>
<td>Aurora</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>7</td>
<td>232513 – Water Treatment</td>
<td>Power Eng. Co.</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>8</td>
<td>233423 – HVAC Power Ventilators</td>
<td>Cook</td>
<td>Greenheck</td>
<td>Twin City</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>9</td>
<td>236423 – Scroll Water Chillers</td>
<td>Carrier</td>
<td>Daikin</td>
<td>Trane</td>
<td>York</td>
<td>$________</td>
<td>$________</td>
</tr>
<tr>
<td>10</td>
<td>238240 – Electric Unit Heaters</td>
<td>Qmark</td>
<td>Airtherm</td>
<td>Trane</td>
<td>$________</td>
<td>$________</td>
<td>$________</td>
</tr>
</tbody>
</table>
SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   10. Concrete bases.
   11. Supports and anchorages.
   12. Link Seal

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspaces.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases and accessible tunnels.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. **NBR**: Acrylonitrile-butadiene rubber.

### 1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

### 1.5 QUALITY ASSURANCE

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

B. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

### 1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless 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.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
2.4 TRANSITION FITTINGS

A. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
   ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

   1. Manufacturers:
      b. Fernco, Inc.
      d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.
   d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

D. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

2.10 LINK SEAL

A. Link-Seal® Modular Seal Pressure Plates
   1. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
      a. Izod Impact - Notched = 2.05 ft-lb/in. per ASTM D-256
         Flexural Strength @ Yield = 30,750 psi per ASTM D-790
         Flexural Modulus = 1,124,000 psi per ASTM D-790
         Elongation Break = 11.07% per ASTM D-638
         Specific Gravity = 1.38 per ASTM D-792
   2. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on
the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a “Hex Nut Interlock” designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer’s name molded into it.

3. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

4. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be: 316 Stainless Steel per ASTM F593-95, with a 85,000 psi average tensile strength.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 SEISMIC REQUIREMENTS

A. Comply with SEI/ASCE 7 and with requirements for seismic seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:
   a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.

g. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

h. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

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. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

   1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

   1. Install steel pipe for sleeves smaller than 6 inches in diameter.

   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten
bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

J. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 220500
SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 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, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.


E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Link-Seal
4. Metraflex Company (The).
5. Pipeline Seal and Insulator, Inc.
6. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: **EPDM-rubber** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: **Carbon steel**.
3. Connecting Bolts and Nuts: **Carbon steel, with corrosion-resistant coating**, of length required to secure pressure plates to sealing elements.

2.3 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: **5000-psi, 28-day** compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide **1-inch** annular clear space between piping and concrete slabs and walls.

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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. 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.
3. 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 \( \frac{1}{4}\text{-inch} \) 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. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6: **Cast-iron wall sleeves.**
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6: **Cast-iron wall sleeves with sleeve-seal system.**
         1) Select sleeve size to allow for \( 1\text{-inch} \) annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: **Cast-iron wall sleeves with sleeve-seal system.**
         1) Select sleeve size to allow for \( 1\text{-inch} \) annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Concrete Slabs above Grade:

5. Interior Partitions:
SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Escutcheons.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
   B. Install escutcheons with ID to 2 inch (50mm), tube, and insulation of insulated piping and with OD that completely covers opening.
      1. Escutcheons for New Piping:
         a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type with polished, chrome-plated finish.
b. Insulated Piping: One-piece, **stamped-steel type with chrome-plated finish**

c. Bare Piping **2 inch** and Smaller at Wall and Floor Penetrations in Finished Spaces: **One-piece, cast-brass** type with polished, chrome-plated finish.

d. Bare Piping **2 inch** and Smaller at Ceiling Penetrations in Finished Spaces: **One-piece, cast-brass** type with polished, chrome-plated finish.

e. Bare Piping **2 inch** and Smaller in Unfinished Service Spaces: **One-piece, cast-brass** type with polished, chrome-plated or rough-brass finish.

f. Bare Piping **2 inch** and Smaller in Equipment Rooms: **One-piece, cast-brass** type with polished, chrome-plated or rough-brass finish.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518
SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Bronze angle valves.
   2. Bronze ball valves.

B. Related Sections:
   1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
   3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.
1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 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.
   3. Set angle valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.

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

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
   2. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Hammond Valve.
   e. Lance Valves; a division of Advanced Thermal Systems, Inc.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   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 or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Hammond Valve.
d. Lance Valves; a division of Advanced Thermal Systems, Inc.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   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 or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

C. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. DynaQuip Controls.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Red-White Valve Corporation.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Three piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

D. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Hammond Valve.
   c. Milwaukee Valve Company.
d. NIBCO INC.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Three piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

PART 3 - EXECUTION

3.1 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.

3.2 VALVE INSTALLATION
   A. Locate valves for easy access and provide separate support where necessary.
   B. Install valves in horizontal piping with stem at or above center of pipe.
   C. Install valves in position to allow full stem movement.

3.3 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.
3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   
   1. Shutoff Service: Ball.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.5 DOMESTIC COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.

END OF SECTION 220523
SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, \( I_p \), shall be taken as 1.5 if any of the following conditions apply:
1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I_p, equal to 1.0.

1.5 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.
5. Mechanical Anchors: ICC-ES Evaluation Reports validating ‘Cracked Concrete’ testing per A.C. 193 must be provided for anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.
D. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

1.7 QUALITY ASSURANCE


B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
1. Anvil International.
2. AAA Technology & Specialties Co., Inc.
5. Carpenter & Paterson, Inc.
6. Empire Industries, Inc.
7. ERICO/Michigan Hanger Co.
8. FNW/Ferguson Enterprises
10. Grinnell Corp.
11. GS Metals Corp.
13. PHD Manufacturing, Inc.
14. PHS Industries, Inc.
15. Piping Technology & Products, Inc.
16. Tolco Inc.
17. Simpson Strong-Tie Co.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. Anvil International.
2. B-Line Systems, Inc.; a division of Cooper Industries.
3. ERICO/Michigan Hanger Co.; ERISTRUT Div.
4. FNW/Ferguson Enterprises
5. GS Metals Corp.
6. Hilti, Inc.
8. Thomas & Betts Corporation.
9. Tolco Inc.
10. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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.

2.6 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.

1. Manufacturers:
   a. Hilti, Inc.
   b. MKT Fastening, LLC.
   c. Powers Fasteners.
   d. Simpson Strong-Tie Co.

B. Mechanical-Expansion Anchors and Concrete Screws: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. For anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems, Anchors shall have been tested for ‘Cracked Concrete’ per A.C. 193 per a valid ICC-ES Evaluation Report. Manufacturers with these anchors have been designated below with: ‘*’

1. Manufacturers:
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.
g. Simpson Strong-Tie Co. *

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:
   a. Anvil International.
   b. ERICO/Michigan Hanger Co.
   c. MIRO Industries.
   d. Unipure

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:
   a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:
   a. Anvil International.
   b. ERICO/Michigan Hanger Co.
   c. MIRO Industries.
   d. Portable Pipe Hangers.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:
a. Anvil International.
b. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:
   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. 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 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. 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 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18 or Simpson Blue Banger Concrete insert with UL & FM approvals): 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.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Steel 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 building structure.

C. 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 above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Powder actuated fasteners shall not be used for seismic bracing attachments.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. For anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems, anchors shall have been tested for ‘Cracked Concrete’ per A.C. 193 and shall have a valid ICC-ES Evaluation Report.

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
H. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.

5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 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 contours of welded surfaces match adjacent contours.

3.4 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.

3.5 PAINTING

A. Touch Up: 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 minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following restraints and vibration isolation as defined in Section 230548 “Vibration Isolation and Seismic Controls for HVAC” for the following:

1. Plumbing Piping.
2. Plumbing Equipment.

PART 2 - PRODUCTS

2.1 (NOT USED)

PART 3 - EXECUTION

3.1 (NOT USED)

END OF SECTION 220548
SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pipe labels.
   2. Stencils.
   3. Valve tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Valve numbering scheme.
D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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.

PART 2 - PRODUCTS

2.1 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid 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, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.2 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. 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

3.1 PREPARATION

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

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

   1. Identification Paint: Use for contrasting background.

C. 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 branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

D. Pipe Label Color Schedule:

   1. Domestic Water Piping:

   2. Sanitary Waste and Storm Drainage Piping:

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; 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 according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

   1. Valve-Tag Size and Shape:
c. Low-Pressure Compressed Air: 1-1/2 inches, round.
d. High-Pressure Compressed Air: 1-1/2 inches, round.

2. Valve-Tag Color:

   c. Low-Pressure Compressed Air: Comply with ASME A13.1.
   d. High-Pressure Compressed Air: Comply with ASME A13.1.

3. Letter Color:

   c. Low-Pressure Compressed Air: Comply with ASME A13.1.
   d. High-Pressure Compressed Air: Comply with ASME A13.1.

END OF SECTION 220553
SECTION 220719 - PLUMBING PIPING INSULATION.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes insulating the following plumbing piping services:
      1. Domestic cold-water piping.

1.3 DEFINITIONS:
   A. Refer to Section 220500 “Common Work Results for Plumbing”.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
      2. Detail attachment and covering of heat tracing inside insulation.
      3. Detail insulation application at pipe expansion joints for each type of insulation.
      4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
      5. Detail removable insulation at piping specialties, equipment connections, and access panels.
      6. Detail application of field-applied jackets.
      7. Detail application at linkages of control devices.

1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified Installer.
   B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

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.

1.7 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.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "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.

1.9 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

2.1 INSULATION MATERIALS

B. Insulation for below-ambient service requires a vapor-barrier.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. 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.

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

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

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553:
   1. Type II and ASTM C 1290, Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000-Degree Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   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,
      a. Without factory-applied jacket with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
2.2 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, provide the following:
      a. Ramco Insulation, Inc.; Super-Stik.

   1. Products: Subject to compliance with requirements, provide the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 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. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      d. K-Flex USA; R-373 Contact Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Éco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      d. Speedline Corporation; Polyco VP Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 501.
   d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 570.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide the following:

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 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.

2.7 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. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      c. Proto Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.

   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: Color-code jackets based on system.
      a. 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.

C. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
2. **Aluminum Jacket:** Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper. [3-mil thick, heat-bonded polyethylene and kraft paper] [2.5-mil thick polysurlyn].
   d. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper. [2.5-mil thick polysurlyn].
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 **TAPES**

A. **ASJ Tape:** White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

   1. **Products:** Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. **PVC Tape:** White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

   1. **Products:** Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal ¾-inch-wide, stainless steel or Monel.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Engineered Brass Company.
   b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   c. McGuire Manufacturing.
   d. Plumberex.
   e. Truebro; a brand of IPS Corporation.
   f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
BYU MOTION PICTURE STUDIO
CHILLER PLANT

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Truebro; a brand of IPS Corporation.
   b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 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.

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

3.3 GENERAL INSTALLATION REQUIREMENTS
   A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
   B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
   C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
   D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
   E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at:
      a. 2 inches o.c.
      b. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
P. 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.

3.4 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 078413 "Penetration Firestopping" 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 078413 "Penetration Firestopping."
3.5 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, 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 locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 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.
3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Insulation shall have a k value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. **NPS 1-1/2 and Smaller:** Insulation shall be one of the following;

   a. Flexible Elastomeric:
      1) **1 inch** thick
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I:
      1) **1 inch** thick

   B. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

   1. All Pipe Sizes: Insulation shall be one of the following:

      a. Flexible Elastomeric:
         1) **3/4 inch thick.**
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I:
         1) **3/4 inch thick.**
3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: \textbf{2 inches} thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: \textbf{2 inches} thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. PVC:
      a. White: 20 mils thick

D. Piping, Exposed:
   1. PVC:
      a. White: \textbf{30 mils thick}

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed:
   1. Aluminum, Stucco Embossed: 0.016 inch thick.

3.14 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719
SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
      2. Encasement for piping.
   B. Related Requirements:
      1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS
   A. Product Data: For transition fittings and dielectric fittings.
   B. Delegated-Design Submittal:
      1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
      2. Locations of pipe anchors and alignment guides and expansion joints and loops.
      3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

1.4 INFORMATIONAL SUBMITTALS
   A. System purging and disinfecting activities report.
   B. Field quality-control reports.
1.5 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 Construction Manager or owner no fewer than two days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

C. All piping shall be American made and tested; no import pipe will be permitted.

D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.

E. All piping installed in or passing through a plenum must be plenum rated, fire wrapped, or installed in a metal conduit.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L 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.


E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
4. Solder-joint or threaded ends.
2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cascade Waterworks Manufacturing.
      b. Dresser, Inc.; Piping Specialties Products.
      c. Ford Meter Box Company, Inc. (The).
      d. JCM Industries.
      e. Romac Industries, Inc.
      f. Smith-Blair, Inc.; a Sensus company.
      g. Viking Johnson.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Nipples and Waterways:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elster Perfection Corporation.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Matco-Norca.
d. Clearflow/Perfection Corp.
e. Precision Plumbing Products, Inc.
f. Victaulic Company.

3. Electroplated steel nipple or waterway complying with ASTM F 1545 or ANSI/NSF-61 Compliant.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene or LTHS.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Polypropylene pipe in or passing through plenums must be fire wrapped or installed in a metal conduit.

C. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

D. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

E. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
   1. Piping will be drained seasonally for freeze protection.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
I. Install seismic restraints on piping. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. 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.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping to permit valve servicing.

N. 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.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 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. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION
A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.5 DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples/waterways.

3.6 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for seismic-restraint devices in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code. Comply with requirements for connection sizes in Division 22 plumbing fixture Sections.

3.8 IDENTIFICATION
A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 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. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. 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. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.
3.11 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.

3.12 PIPING SCHEDULE

A. Some piping types and sizes mentioned in this section may not be used on this project.

B. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

C. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.

E. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K wrought-copper, solder-joint fittings; and brazed joints.

F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

G. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast-copper, solder-joint fittings; and soldered joints.
3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use **ball** for piping NPS 3 and smaller.
2. Drain Duty: Hose-end drain valves.

END OF SECTION 221116
SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Hose bibbs.
   2. Wall hydrants.
   3. Drain valves.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For domestic water piping specialties to include in
   emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
   Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for
   intended use.
B. NSF Compliance:
      domestic water piping components.
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1
      through 9."

PART 2 - PRODUCTS

2.1 HOSE BIBBS

A. Hose Bibbs:
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.2 WALL HYDRANTS

A. Non-freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   c. Prier Products, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
10. Operating Keys: Two with each wall hydrant.

2.3 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
2. Pressure Rating: 400-psig minimum CWP.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

END OF SECTION 221119
SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.

1.3 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**.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS
   A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
      1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
   B. Field quality-control reports.

1.6 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 PROJECT 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 no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: All cast-iron waste, vent and sewer pipe and fittings shall conform to the requirements of CISPI Standard 301 and ASTM A 888. All products shall be marked with the collective trademark of the Cast Soil Pipe Institute and shall be listed by NSF International or receive prior approval of the engineer. All cast-iron pipe and fittings shall be American made and tested. Non-compliant import cast-iron products will not be permitted. Any non-compliant cast-iron product installed by the contractor on this project will be replaced at the contractor's expense and shall include all repairs, patching, painting and other incidental work required to return the project to its pre-remediation state.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AB&I Foundry
   b. Charoltte Pipe
   c. Tyler Pipe

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO.
   b. Ideal
c. Mission Rubber Company; a division of MCP Industries, Inc.
d. Tyler Pipe.

3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Husky SD 4000.
   b. Clamp-All Corp HI-TORQ 125.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer 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."

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."
3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. 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. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: **2 percent downward in direction of flow for piping.**
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

N. 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."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install underground PVC piping according to ASTM D 2321.

P. Install engineered soil and waste drainage and vent piping systems as follows:


Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

3. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 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. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.
3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling or valve and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
   6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make fixture and equipment connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION
A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test sanitary drainage 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water**. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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**. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.

3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of 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.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping **NPS 3** and smaller shall be the following:

1. Hubless, cast-iron soil pipe and fittings **CISPI** hubless-piping couplings; and coupled joints.

C. Aboveground, vent piping **NPS 3** and smaller shall be the following:

1. Hubless, cast-iron soil pipe and fittings **CISPI** hubless-piping couplings; and coupled joints.
D. Underground, soil, waste, and vent piping **NPS 3** and smaller shall be **any of** the following:

1. Hubless, cast-iron soil pipe and fittings **CISPI** hubless-piping couplings; and coupled joints.
2. **Solid-wall** PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316
SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.

1.3 DEFINITIONS
A. FOG: Fats, oils, and greases.
B. FRP: Fiberglass-reinforced plastic.
C. HDPE: High-density polyethylene plastic.
D. PE: Polyethylene plastic.
E. PP: Polypropylene plastic.
F. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
A. Field quality-control test reports.
B. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
   g. Sun Drainage Products

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Oatey.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.
   h. Sun Drainage Products

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
15. Size: Same as connected branch.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
   g. Sun Drainage Products

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: See Schedule at end of this Section:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Sun Drainage Products

5. Seepage Flange: Required.
6. Anchor Flange: Not required.
7. Outlet: Bottom.
8. Trap Material: Cast iron.
10. Provide with Trap Guard.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch- minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch > above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

C. Stack Flashing Fittings:
   1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

D. Vent Cap Filters:
   1. Description: Activated carbon filter in housing for installation at vent terminal as manufactured by Sweet Filter.
   2. Size: Same as connected stack vent or vent stack.

2.4 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.


C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

C. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

D. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

G. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

H. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

I. Install deep-seal traps on floor drains and other waste outlets, if indicated.

J. 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.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

M. Install vent cap filters on each vent pipe passing through roof.

N. Install grease removal devices on floor as required by the manufacturer complete with all controls and power wiring.

O. Install wood-blocking reinforcement for wall-mounting-type specialties.

P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Removal Devices: Connect controls, electrical power, factory-furnished accessories, and inlet, outlet, and vent piping to unit.
D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 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.

3.7 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain grease removal devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 221319
SECTION 23 0100 - MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.

B. All sections of Division 21, 22, & 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Division.

C. Mechanical equipment that is pre-purchased if any will be assigned to the Mechanical Contractor. By assignment to the Mechanical Contractor, the Mechanical Contractor shall accept and installed the equipment and provide all warranties and guarantees as if the Mechanical Contractor had purchased the equipment.

D. Construction Indoor-Air Quality Management
   1. Comply with SMACNA’s “SMACNA IAQ Guideline for Occupied Buildings under Construction.”
      a. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section “Temporary Facilities and Controls,” install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
      b. Replace all air filters immediately prior to occupancy.

1.2 SCOPE OF WORK

A. The project described herein is the BYU Motion Picture Studio – Chilled Water Plant. This work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.

B. This Division will schedule the boiler inspection and pay for all costs associated with certifying the boiler with the state.

1.3 CODES & ORDINANCES

A. All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will be held to complete all work necessary to meet these requirements without extra expense to the
Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.

B. Applicable codes:

1.4 INDUSTRY STANDARDS

A. All work shall comply with the following standards.
1. Associated Air Balance council (AABC)
2. Air Conditioning and Refrigeration Institute (ARI)
3. Air Diffusion council (ADC)
4. Air Movement and Control Association (AMCA)
5. American Gas Association (AGA)
6. American National Standards Institute (ANSI)
7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
8. American Society of Mechanical Engineers (ASME)
10. American Water Works Association (AWWA)
11. Cooling Tower Institute (CTI)
12. ETL Testing Laboratories (ETL)
13. Institute of Electrical and Electronic Engineers (IEEE)
14. Hydronics Institute (HI)
15. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
17. National Electrical Code (NEC)
18. National Electrical Manufacturers Association (NEMA)
19. National Electrical Safety code (NESC)
21. Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA)
22. Underwriters Laboratories (UL)
23. Tubular Exchanger Manufacturers Association, Inc. (TEMA)
24. Heat Exchanger Institute (HEI)
25. Hydraulic Institute (HI)
26. Thermal Insulation Manufacturer's Association (TIMA)
27. Scientific Apparatus Makers Association (SAMA)

B. Compliance Verification:
1. All items required by code or specified to conform to the ASME code shall be stamped with the ASME seal.
2. Form U-1, the manufacturer's data report for pressure vessels, is to be included in the Operation and Maintenance Manuals. National Board Register (NBR) numbers shall be provided where required by code.

3. Manufactured equipment which is represented by a UL classification and/or listing, shall bear the UL or equivalent ETL label.

1.5 UTILITIES & FEES

A. All fees for permits required by this work will be paid by this division. The contractor shall obtain the necessary permits to perform this work. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall furnish smoke generators when required for testing, furnish glycol for glycol piping systems, full load of salt to fill brine tank for water softening system, furnish cleaners and water treatment additives.

1.6 SUBMITTALS AND SHOP DRAWINGS

A. General: As soon as possible after the contract is awarded, but in no case more than 45 calendar days thereafter, the Contractor shall submit to the Architect manufacturer’s data on products and materials to be used in the installation of mechanical systems for this project. The review of the submitted data will require a minimum of 14 days. The first day starts after the day they are received in the engineer’s office to which the project is being constructed from. If the Contractors schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within 14 days of returned submittals. Refer to each specification section for items requiring submittal review. If the re-submittal is returned a 2nd time for correction the Contractor will provide the specific equipment that is specified on the drawings and/or the specifications. Written approval of the Owner's Representative shall be obtained before installing any such equipment or materials for the project.

B. Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. In no way does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. Regardless of any items overlooked by the submittal review, the requirements of the contract drawings and specifications must be followed and are not waived or superseded in any way by the review.

C. By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.

D. If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined
above, the contractor shall reimburse the engineer for additional time and expenses at the engineer’s current, recognized, hourly rates.

E. Submittal Format: At the contractor’s discretion, project submittals may be in either of the formats described in the following paragraphs, but mixing the two formats is not acceptable.

1. Hardcopy Submittal Format: **Six (6)** copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for this project will be provided for review. The submittals shall be prepared in an orderly manner, contained in a 3-ring loose-leaf binder with index and identification tab for each item or group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within **120 days** of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.
   a. Submitted literature shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.
   b. Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.
   c. Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

2. Electronic Submittal Format: Identify and incorporate information in each electronic submittal file as follows:
   a. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within **120 days** of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.
   b. Submitted electronic file shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.
   c. Submitted electronic file shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.
d. Submitted electronic file shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

e. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

f. Name file with submittal number or other unique identifier, including revision identifier.

g. **Electronic file shall be completely electronically searchable or it will be rejected.**

h. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by:

1) **Architect.**
2) **Architect and Construction Manager.**

i. Transmittal Form for Electronic Submittals:

1) Use one of the following options acceptable to the Owner;
   a) **Software-generated form from electronic project management software.**
   b) **Electronic form.**

2) The Electronic Submittal shall contain the following information:
   a) Project name.
   b) Date.
   c) Name and address of Architect.
   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.

j. Metadata: Include the following information as keywords in the electronic submittal file metadata:

1) Project name.
2) Number and title of appropriate Specification Section.
3) Manufacturer name.
4) Product name.

1.7 DRAWINGS AND MEASUREMENTS

A. Construction Drawings: The contract document drawings show the general design, arrangements, and extent of the system. In certain cases, the drawings may include details that show more nearly exact locations and arrangements; however, the locations, as shown diagrammatically, are to be regarded as general.

B. It shall be the work of this Section to make such slight alterations as may be necessary to make adjustable parts fit to fixed parts, leaving all complete and in proper shape when done. All dimensions given on the drawings shall be verified as related to this work and with the Architect's office before work is started.

C. This Section shall carefully study building sections, space, clearances, etc., and then provide offsets in piping or ductwork as required to accommodate the building structure without additional cost to the Owner. In any case and at any time during the construction process, a change in location required by obstacles or the installation of other trades not shown on the mechanical plans shall be made without charge.

D. The drawings shall not be scaled for roughing in measurements nor shall they be used as shop drawings. Where drawings are required for these purposes or where drawings must be made from field measurements, the Contractor shall take the necessary measurements and prepare the drawings. Shop drawings of the various subcontractors shall be coordinated to eliminate all interferences and to provide sufficient space for the installation of all equipment, piping, ductwork, etc.

E. The drawings and specifications have been prepared to supplement each other and they shall be interpreted as an integral unit with items shown on one and not the other being furnished and installed as though shown and called out on both.

F. Coordination Drawings: The contractor shall provide coordination drawings for mechanical rooms, fan rooms, equipment rooms, and congested areas to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch= 1 foot and of such detail as may be required by the Engineer to fully illustrate the work. These drawings shall include all piping, conduit, valves, equipment, and ductwork.

G. Sheet-metal shop drawings will be required for all ductwork in the entire building. These drawings will show all ductwork in the entire building and shall be coordinated with architectural, structural and electrical portions of the project. The contractor shall specifically obtain copies of the structural shop drawings and shall coordinate the ductwork shop drawings with approved structural members. These drawings shall be submitted to the engineer for review prior to any fabrication. The contractor is responsible for all modifications necessary to accommodate duct installation within the structural, architectural and electrical restrictions. These drawings, once reviewed by the engineer, will be made available to all mechanical, electrical, and fire sprinkler subcontractors to coordinate installation of their work.
1.8 CONTRACTOR'S USE OF BUILDING EQUIPMENT

A. The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement. New filter media shall be installed in air handlers at the time systems are turned over to the owner.

1.9 EXISTING CONDITIONS

A. The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by new construction.

B. The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.

C. The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them impossible as shown on drawings, then notification of such shall immediately be given to the Owners Representative for a decision.

1.10 EQUIPMENT CAPACITIES

A. Capacities shown for equipment in the specifications and on the drawings are the minimum acceptable. No equipment shall be considered as an alternate that has capacities or performance less than that of design equipment.

B. All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers' standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

1.11 SEISMIC REQUIREMENTS FOR EQUIPMENT

A. All equipment shall be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code. Refer to section Mechanical Vibration Controls and Seismic
Restraints. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

1.12 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.

B. The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.

C. The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.

D. The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with Articles 110-16 and 384-4 of the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

1.13 RESPONSIBILITY OF CONTRACTOR

A. The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and without expense, all incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.

B. If a conflict arises between the drawings and the specifications the most stringent procedure/action shall be followed. A clarification to the engineer will help to determine the course of action to be taken. If a conflict arises between specification sections the engineer will determine which course of action is to be followed.

1.14 PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES

A. Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division. Include openings information with coordination drawings.
B. Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

1.15 UNFIT OR DAMAGED WORK

A. Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

1.16 WORKMANSHIP

A. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.

1.17 SAFETY REGULATION

A. The Contractor shall comply with all local, Federal, and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.

1.18 ELECTRICAL SERVICES

A. All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage, except power wiring, shall be furnished and installed as work of this Division unless shown to be furnished by Division 26. All such wiring shall be in conduit as required by electrical codes. Wiring in the mechanical rooms, fans rooms and inaccessible ceilings and walls shall be installed in conduit as well. Installation of any and all wiring done under Division 21, 22 and 23 shall be in accordance with the requirements of Division 26, Electrical.

B. All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available.

C. Refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.

D. The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.
1.19 WORK, MATERIALS, AND QUALITY OF EQUIPMENT

A. Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds and all labor shall be done in a most thorough and workmanlike manner.

B. Products or equipment of any of the manufacturers cited herein or any of the products approved by the Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.

C. The Execution portions of the specifications specify what products and materials may be used. Any products listed in the Product section of the specification that are not listed in the Execution portion of the specification may not be used without written approval by the Engineer.

D. The access to equipment shown on the drawings is the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.

E. All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.

F. All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

1.20 PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

A. All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.

B. All open duct and pipe openings shall be adequately covered at all times.

1.21 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule and the seismic supplier shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job
BYU MOTION PICTURE STUDIO
CHILLER PLANT

site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.

C. All costs for this work shall be included in the prices quoted by equipment suppliers.

1.22 EQUIPMENT LUBRICATION

A. The Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.

B. Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.

C. Detergent oil as used for automotive purposes shall not be used for this work.

1.23 CUTTING AND PATCHING

A. No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.

B. When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

1.24 EXCAVATION AND BACKFILLING

A. All necessary excavations and backfilling for the Mechanical phase of this project shall be provided as work of this Division. Trenches for all underground pipelines shall be excavated to the required depths. The bottom of trenches shall be compacted hard and graded to obtain required fall. Backfill shall be placed in horizontal layers, not exceeding 12 inches in thickness, and properly moistened. Each layer shall be compacted, by suitable equipment, to a density of not less than 95 percent as determined by ASTM D-1557. After pipelines have been tested, inspected, and approved, the trench shall be backfilled with selected material. Excess earth shall be hauled from the job site. Fill materials approved by the Architect shall be provided as work of this Division.

B. No trenches shall be cut near or under any footings without consultation first with the Architect's office. Any trenches or excavations more than 30 inches deep shall be tapered,
shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning. This protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

1.25 ACCESS

A. Provide access doors in walls, ceilings and floors by this division unless otherwise noted. For access to mechanical equipment such as valves, dampers, VAV boxes, fans, controls, etc. Refer to Division 8 for door specifications. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation. If doors are not specified in Division 8, provide the following: Doors in ceilings and wall shall be equal to JR Smith No. 4760 bonderized and painted. Doors in tile walls shall be equal to JR Smith No. 4730 chrome plated. Doors in floors shall be equal to JR Smith No. 4910.

B. Valves: Valve must be installed in locations where access is readily available. If access is compromised, as judged by the Mechanical Engineer, these valves shall be relocated where directed at the Contractors expense.

C. Equipment: Equipment must be installed in locations and orientations so that access to all components requiring service or maintenance will not be compromised. If access is compromised, as judged by the Mechanical Engineer, the contractor shall modify the installation as directed by the Engineer at the Contractors expense.

D. It is the responsibility of this division to install terminal boxes, valves and all other equipment and devices so they can be accessed. If any equipment or devices are installed so they cannot be accessed on a ladder a catwalk and ladder system shall be installed above the ceiling to access and service this equipment.

1.26 CONCRETE BASES AND INSERTS

A. Bases: The concrete bases shall be provided and installed as work by this division. This Division shall be responsible for the proper size and location of bases and shall furnish all required anchor bolts and sleeves with templates to be installed as work of Division 3, Concrete.

B. All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all around.

C. Inserts: Where slotted or other types of inserts required for this work are to be cast into concrete, they shall be furnished as work of this Division.

D. Concrete inserts and pipe support systems shall be equal to Unistrut P3200 series for all piping where more than one pipe is suspended at a common location. Spacing of the inserts shall
match the size and type of pipe and of ductwork being supported. The Unistrut insert and pipe support system shall include all inserts, vertical supports, horizontal support members, clamps, hangers, rollers, bolts, nuts, and any other accessory items for a complete pipe-supporting system.

1.27 CLEANING AND PAINTING

A. Cleaning: After all tests and adjustments have been made and all systems pronounced satisfactory for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated members, fixture, and equipment installed under this Section and leave them ready for painting. He shall refinish any damaged finish and leave everything in proper working order. The Contractor shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere, caused by his workman or for which he is responsible. He shall remove all stickers on plumbing fixtures, do all required patching up and repair all work of others damaged by this division of the work, and leave the premises in a clean and orderly condition.

B. Painting: Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9, Painting.

C. Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon completion of job. Any necessary refinishing to match original shall be done. Do not paint over nameplates, serial numbers, or other identifying marks.

D. Removal of Debris, Etc: Upon completion of this division of the work, remove all surplus material and rubbish resulting from this work, and leave the premises in a clean and orderly condition.

1.28 CONTRACT COMPLETION

A. Incomplete and Unacceptable Work: If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

B. Maintenance Instructions: The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists.

C. Instructions To Owner's Representatives: In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner's representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not reduced. The ATC Contractor
shall provide 4 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractor.

D. Guarantee: By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subcontractors as their interests may appear.

E. The guarantee so assumed by the Contractor and as work of this Section is as follows:
1. That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.
2. That the circulation of water shall be complete and even.
3. That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.
4. That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.
5. That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.
6. All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period. If the contractor needs to provide temporary heating or cooling to the building and or needs to insure systems are installed properly and or to meet the project schedule the guaranteed of all systems and equipment shall be as indicated above, on year from the date of the Architect’s Certificate of Substantial Completion.
7. All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.
8. If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean.

1.29 CURBS

A. Unless otherwise noted in these specifications or on the documents all roof curbs for all equipment are to be provided by Division 22 and 23.
1.30 TEST RUN

A. The Mechanical Contractor shall operate the mechanical system for a minimum of 30 days to prove the operation of the system.

1.31 EQUIPMENT STARTUP AND CHECKOUT:

A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.

B. This contractor shall coordinate commissioning procedures and activities with the commissioning agent.

1.32 DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

B. Proceed with demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

C. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

D. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

E. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

F. Maintain adequate ventilation when using cutting torches.

G. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

H. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

I. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
J. Dispose of demolished items and materials promptly.

K. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

L. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

M. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

N. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

O. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

P. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

END OF SECTION 23 0100
SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
7. Grout.
8. Equipment installation requirements common to equipment sections.
10. Concrete bases.
11. Supports and anchorages.
12. Link-Seal

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspace.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases, and accessible tunnels.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless 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.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BA1, silver alloy for refrigerant piping, unless otherwise indicated.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
   a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
   a. Thompson Plastics, Inc.

2.5 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for 300-psig minimum working pressure as required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.


2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.9 GROUT
A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: \textbf{5000-psi}, 28-day compressive strength.

2.10 LINK-SEAL MODULAR SEAL PRESSURE PLATES
A. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
   1. Izod Impact - Notched = \textbf{2.05ft-lb/in.} per ASTM D-256
   2. Flexural Strength @ Yield = \textbf{30,750 psi} per ASTM D-790
   3. Flexural Modulus = \textbf{1,124,000 psi} per ASTM D-790
   4. Elongation Break = 11.07% per ASTM D-638
   5. Specific Gravity = 1.38 per ASTM D-792

B. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-410-425-475-500-525-575-600 shall incorporate an integral recess known as a “Hex Nut Interlock” designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer’s name molded into it.

C. For fire service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

D. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be:
   1. 316 Stainless Steel per ASTM F593-95, with a \textbf{85,000 psi} average tensile strength.
3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   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. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. PVC Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
         1) Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble
mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping **NPS 2** and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping **NPS 2-1/2** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.


3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch** centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section “Miscellaneous Cast-in-Place Concrete.”

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.9 LINK SEAL

A. Provide Link Seal at all piping penetrations from the outside.

END OF SECTION 230500
SECTION 230519
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. BTU / Heat transfer meters.
B. Pressure gages and pressure gage taps.
C. Digital thermometers and thermometer wells.

1.02 RELATED REQUIREMENTS
A. Section 230923 - Direct-Digital Control System for HVAC.
B. Section 230943 - Pneumatic Control System for HVAC.
C. Section 230993 - Sequence of Operations for HVAC Controls.
D. Section 232113 - Hydronic Piping.
E. Section 232213 - Steam and Steam Condensate Piping.

1.03 REFERENCE STANDARDS
A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2015.
F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2012.
G. AWWA C702 - Cold-Water Meters -- Compound Type; 2015.
I. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
J. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS
A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
C. Project Record Documents: Record actual locations of all BTU meter sensors and taps. Final locations shall be pre-approved by owner's representative.
D. Operation and Maintenance Data: _____________________.
E. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.

1.05 FIELD CONDITIONS
A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
PART 2 PRODUCTS

2.01 BTU / HEAT TRANSFER METERS

A. Manufacturers:
   1. General Electric;

B. Meter: Panametrics Ultrasonic Liquid Flowmeter - Meter and components shall be owner furnished and contractor installed.
   1. Model: GE DigitalFlow DF868
   2. Flow measurement: Transit-Time mode.
   3. Channels: Two.
   4. Transducer type: Wetted flow.
   5. RTDs: (2) required, (1) for supply pipe and (1) for return pipe.
   6. RTD Thermowells: 1/2” MNPT; (2) required, (1) for supply pipe and (1) for return pipe.
   7. Transducer taps: 3” pipe and larger flow section only for “V path”.
   8. Panadapta plugs (for flow transducers): 1” MNPT; See installation detail on drawings.

C. Installation:
   1. Engineering drawings will recommend a location for the mounted meter and for the flow section. The flow section shall be located in the side of the horizontal return piping and the location shall be free of any flow obstructions and fittings. The location shall also be downstream of any branch combines, before any system branch takeoffs, and before the system isolation valve. It shall have at least thirty or more pipe diameters of straight pipe.
   2. The Engineer will review relevant historical telemetry and confirm velocity with the Owner’s Representative in advance (Utilities Analysis 801-422-5403). The engineer will specify and call out piping reducers in the beginning and end of the flow section, if needed to insure the peak design flow rate is at least 6 fps in the flow section.
   3. **Flow Section 3” and larger Pipe, (“V path”):** The flow taps will be positioned with at least twenty pipe diameters of straight pipe upstream and a minimum of ten pipe diameters of straight pipe downstream and without any obstructions. The area between the flow transducers and two feet to each side, must also be free of welds and couplings.
   4. **Flow Section for less than 3” Pipe, (“Face to Face”):** The flow section will begin entering the branch side of a horizontal tee, and then continue horizontally at least four feet to another horizontal tee, and exiting the branch side of the downstream tee. The opposite face of the tees may require bushings to reduce to 1” FNPT, to accommodate the 1” Panadapta Plugs. The flow section shall not be less than 1” nominal pipe size.
   5. The Supply RTD shall be located downstream of the system isolation valve and before any branch take offs. The Return RTD temperature sensor must be located downstream of the flow section and before the system isolation valve. All flow Taps, and RTD Temperature sensors must have a minimum of 18” of clearance away from the pipe, for servicing and maintenance of the sensors. The final placement and location is to be approved by the Owner’s Representative in advance (Utilities Analysis 801-422-5403).
   6. Contractor will install the supplied RTD thermowells, the flow Taps and Panadapta Plugs per the installation detail, provide a pull box within three feet of each RTD temperature sensor and flow transducer, with 1” EMT conduit back to another pull box within three feet of the designated meter mounting location. The contractor will also provide a 120 VAC 15 Amp dedicated circuit to a pull box within three feet of the designated meter mounting location. The contractor will provide a pull box within three feet of the designated meter mounting location, with a 3/4” EMT conduit from the nearest HVAC control panel having MODBUS available. The contractor will provide and install thermometers adjacent to but no closer than 6” of each RTD.

2.02 HTW PRESSURE GAGES

A. Manufacturers:
   1. U.S. Gauge; _____:

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
2. Ashcroft Duragauge; ______:

B. General: ASME B40.100; provide industrial quality pressure gauges of materials, capacities, and ranges indicated; designed and constructed for use in service indicated.
1. Type: Bourdon tube (stress relieved) constructed stainless steel movement with welded joints, sockets, and tip.
2. Size: 6 inch diameter.
3. Case: Flush or surface panel mounting type; cast aluminum; black finish; screwed window bezel ring; cast aluminum or iron flanges with black finish. Flush or surface panel mounting to building.
5. Scale: Black figures set in laminated plastic surface; micrometer adjustable points.
6. Range: 0 - 600 psi.
7. Accessories shall include a stainless steel pressure snubber and a "HEX" 1/2" block and bleed valve.

2.03 PRESSURE GAGES
A. Manufacturers:
1. U.S. Gauge; ______:
2. Marsh Instruments; ______:
3. Omega Engineering, Inc; ______:
4. H. O. Trerice Co.;
5. Weiss Instruments;
6. Ashcroft Inc./Weksler;
7. Substitutions: See Section 016000 - Product Requirements.

B. General: ASME B40.100; provide pressure gauges of materials, capacities, and ranges indicated; designed and constructed for use in service indicated.
1. Type: Liquid filled for use with temperature up to 200 degrees F.
2. Case and Ring: 300 series stainless steel case with polished stainless steel bayonet ring.
5. Window: Clear acrylic or tempered glass.
6. Tube: Phosphor bronze Bourdon.
7. Socket: Brass with restrictor.
10. Accuracy: One percent of full scale.
11. Connection: 1/4" male NPT; provide pressure snubber for water service
12. Range: Place operating pressure in mid-range; conform to the following:
   a. Vacuum: 30" Hg - 15 psi - 30 psi, as needed.
   b. Water: 0 - 100 psi - 160 psi, as needed.

2.04 PRESSURE GAGE TAPPINGS
A. Ball Valve: Brass for maximum 150 psi.

2.05 DIGITAL THERMOMETERS
A. Manufacturers:
1. Dwyer Instruments, Inc; ______:
2. Weiss Instruments, Inc.; ______:
3. Ashcroft, Inc. / Weksler; ______:

B. Thermometers: Designed and constructed for use in service indicated on drawings; variable angle; light powered.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: __________________________________________ __________________________

BYU STANDARD 230519 - 3
SPECIFICATION 2018 REV 1.0
METERS AND GAGES FOR HVAC PIPING
1. Case: High impact ABS.
2. Range: 40 / 300 degrees F.
3. Display: 1/2" LCD digits.
4. Accuracy: 1% of reading or 1 degree F, whichever is greatest.
5. Resolution: 1/10 degree between -19.9 degrees / 199.9 degrees F.
7. Lux Rating: 10 lux.
8. Update Rate: 10 seconds.
10. Ambient Operating Temperature: -30 / 140 degrees F.

2.06 THERMOMETER SUPPORTS
A. Socket: Brass separable sockets for thermometer stems with or without extensions as required; of same manufacturer as thermometer; with cap and chain.

2.07 TEST PLUGS
A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
B. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
C. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Viton core for temperatures up to 400 degrees F.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
C. Provide ball valve to isolate each gauge. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.
D. Install thermometers in piping systems in sockets in short couplings. Ensure that thermowell can be installed in all piping without significantly obstructing flow in pipe. Ensure sockets allow clearance from insulation.
E. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 230943.
F. Provide instruments with scale ranges selected according to service with largest appropriate scale.
G. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
H. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

END OF SECTION
SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Applications.
B. General requirements.
C. Angle valves.
D. Globe valves.
E. Ball valves.
F. Butterfly valves.
G. Check valves.
H. Gate valves.
I. Flow control valves.
J. Chainwheels.

1.02 RELATED REQUIREMENTS
A. Section 078400 - Firestopping.
B. Section 083100 - Access Doors and Panels.
C. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
D. Section 230553 - Identification for HVAC Piping and Equipment.
E. Section 230719 - HVAC Piping Insulation.
F. Section 232113 - Hydronic Piping.

1.03 ABBREVIATIONS AND ACRONYMS
A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. PTFE: Polytetrafluoroethylene.
G. RS: Rising stem.
H. SWP: Steam working pressure.
I. TFE: Tetrafluoroethylene.

1.04 REFERENCE STANDARDS
B. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

The Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

I. ASME B31.9 - Building Services Piping; 2014.
J. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.
P. ASTM A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars; 2012 (Reapproved 2017).
S. AWWA C606 - Grooved and Shouldered Joints; 2015.
T. MSS SP-45 - Bypass and Drain Connections; 2003 (Reaffirmed 2008).
V. MSS SP-68 - High Pressure Butterfly Valves with Offset Design; 2011.
W. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; 2011.
X. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; 2011.
Y. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010.
AA. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
AD. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
AE. MSS SP-125 - Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves; 2010.

1.05 SUBMITTALS
A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.06 QUALITY ASSURANCE
A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________

BYU STANDARD SPECIFICATION 2018 REV 1.0 230523 - 2 GENERAL-DUTY VALVES FOR HVAC PIPING
B. Welding Materials and Procedures: Conform to ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect valve parts exposed to piped medium against rust and corrosion.
2. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
3. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
4. Secure check valves in either the closed position or open position.
5. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
1. Maintain valve end protection and protect flanges and specialties from dirt.
   a. Provide temporary inlet and outlet caps.
   b. Maintain caps in place until installation.
2. Store valves in shipping containers and maintain in place until installation.
   a. Store valves indoors in dry environment.
   b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
1. Handle large valves with sling, modified to avoid damage to exposed parts.
2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. See Drawings for specific valve locations.

B. Provide the following valves for the applications if not indicated on Drawings:
1. Throttling (Hydronic): Butterfly, Ball, Globe, and Angle.
3. Isolation (Shutoff): Butterfly, Gate, and Ball.
4. Swing Check (Pump Outlet):  
   a. 2 NPS and Smaller: Bronze with stainless steel disc.
   b. 2-1/2 NPS and Larger: Iron with center-guided metal or center-guided with resilient seat.
5. Dead-End: Butterfly, single-flange (lug) type.

C. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

D. Required Valve End Connections for Non-Wafer Types:
1. Steel Pipe:  
   a. 3 NPS and Smaller: Threaded, mechanical compression coupling, grooved ends.
   b. 4 NPS and Larger: Flanged, grooved ends.
2. Copper Tube:  
   a. 3 NPS and Smaller: Threaded, mechanical compression coupling, grooved ends (Exception: Solder-joint valve-ends).
   b. 4 NPS and Larger: Flanged, grooved ends.

E. Chilled Water Valves:
1. 2 NPS and Smaller, Brass, Bronze, and Stainless Steel Valves:  
   a. Threaded ends.
   b. Angle: Stainless steel disc, Class 150.
   c. Ball: Full port, one piece, stainless steel trim.
   d. Swing Check: Non-metallic or stainless steel disc, Class 150.
   e. Gate: NRS, Class 150.
   f. Globe: Non-metallic or stainless steel disc, Class 150.
2. 2-1/2 NPS and Larger, Iron Valves:  
   a. 2-1/2 NPS to 4 NPS: Threaded ends.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  ________________
b. Ball: 2-1/2 NPS to 10 NPS, Class 150.
c. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, stainless steel disc, EPDM seat, 200 CWP.
d. Single-Flange Butterfly: 14 NPS to 24 NPS, stainless steel disc, EPDM seat, 150 CWP.
e. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
g. Swing Check: Metal seats, Class 150.
h. Swing Check with Closure Control: 2-1/2 NPS to 12 NPS, lever and spring, Class 125.
i. Grooved-End Check: 3 NPS to 12 NPS, 300 CWP.
j. Center-Guided Check: Compact-wafer, metal seat, Class 150.
k. Plate-Type Check: Dual plate, resilient seat, Class 150.
l. Gate: NRS or OS&Y, Class 150.
m. Globe: Class 150.

G. Heating Hot Water Valves:
   1. 2 NPS and Smaller, Brass and Bronze Valves:
      a. Threaded or Propress ends.
      b. Ball: Full port, one piece, stainless steel trim.
      c. Swing Check: Bronze disc, Class 125.
   2. 2-1/2 NPS and Larger, Iron Valves:
      a. 2-1/2 NPS to 12 NPS: Flanged or grooved ends.
      b. Ball: 2-1/2 NPS to 4 NPS, Class 150.
      c. Lug Wafer Butterfly: 2-1/2 NPS to 12 NPS, stainless steel disc, EPDM seat, 200 CWP.
      d. Lug Wafer Butterfly: 14 NPS to 24 NPS, stainless steel disc, EPDM seat, 150 CWP.
      e. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
      g. Swing Check: Metal seats, Class 125.
      h. Swing Check: 2-1/2 NPS to 12 NPS, lever and spring closure control, Class 125.
      i. Grooved-End Swing Check: 3 NPS to 12 NPS, 300 CWP.
      j. Center-Guided Check: Compact-wafer, metal seat, Class 125.
      k. Plate-Type Check: Single plate, metal seat, Class 125.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
   2. Handwheel: Valves other than quarter-turn types.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for valve mounting height of 7'-0" or higher. Chain shall be accessible from within 4'-0" of finished floor.

D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
   1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Memory Stops: Fully adjustable after insulation is installed.

E. Memory Stops: Fully adjustable after insulation is installed. Use only where indicated on drawings.

F. Valve-End Connections:

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
5. Grooved End Connections: AWWA C606.

G. General ASME Compliance:

H. Bronze Valves:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.03 BRONZE ANGLE VALVES
   1. Comply with MSS SP-80, Type 1.
   3. Ends: Threaded.
   4. Stem: Bronze.
   5. Disc: Bronze, PTFE, or TFE.
   7. Handwheel: Malleable iron or bronze.
   8. Manufacturers:
      a. Milwaukee;__________
      b. Crane;
      c. Nibco;
      d. Mueller;
      e. Substitutions: See Section 016000 - Product Requirements.

2.04 BRONZE GLOBE VALVES
A. Class 125: CWP Rating: 200 psig:.
   1. Comply with MSS SP-80, Type 1.
   3. Ends: Threaded or solder joint.
   4. Stem and Disc: Bronze or PTFE.
   5. Packing: Asbestos free.
      a. Handwheel: Malleable iron or bronze.
      b. Manufacturers:
         1) Milwaukee;__________
         2) Crane;
         3) Nibco;
         4) Apollo;
         5) Substitutions: See Section 016000 - Product Requirements.

2.05 IRON GLOBE VALVES
A. Class 125: CWP Rating: 200 psig:; and Class 250: CWP Rating: 500 psig:.
   1. Comply with MSS SP-85, Type I.
   2. Body: Gray iron; ASTM A126, with bolted bonnet.
   4. Trim: Bronze.
   5. Packing and Gasket: Asbestos free.
   6. Operator: Handwheel or chainwheel.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  ___________________________________
7. Manufacturers:
   a. Milwaukee;
   b. Crane;
   c. Nibco;
   d. Apollo;
   e. Substitutions: See Section 016000 - Product Requirements.

### 2.06 BRASS BALL VALVES

**A. Two Piece, Full Port with Stainless Steel Trim:**
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
5. Ends: Threaded, Grooved, or Propress.
6. Seats: PTFE, TFE, or PTFE or TFE.
7. Stem: Stainless Steel.
8. Ball: Stainless Steel.
9. Manufacturers:
   a. Milwaukee;
   b. Apollo;
   c. Hammond;
   d. Nibco;
   e. Watts;
   f. Substitutions: See Section 016000 - Product Requirements.

**B. Three Piece, Full Port with Stainless Steel Trim:**
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
5. Ends: Threaded, Grooved, or Propress.
6. Seats: PTFE or TFE.
7. Stem: Stainless steel.
9. Manufacturers:
   a. Milwaukee;
   b. Apollo;
   c. Hammond;
   d. Nibco;
   e. Watts;
   f. Substitutions: See Section 016000 - Product Requirements.

### 2.07 BRONZE BALL VALVES

**A. Two Piece, Full Port with [] Trim:**
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
5. Ends: Threaded, Grooved, or Propress.
6. Seats: PTFE or TFE.
7. Stem: Stainless steel.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
9. Manufacturers:
   a. Milwaukee;
   b. Apollo;
   c. Hammond;
   d. Nibco;
   e. Watts;
   f. Substitutions: See Section 016000 - Product Requirements.

B. Three Piece, Full Port with Stainless Steel Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psig.
   3. CWP Rating: 600 psig.
   5. Ends: Threaded, Grooved, or Propress.
   6. Seats: PTFE.
   7. Stem: Stainless steel.
   9. Manufacturers:
      a. Milwaukee;
      b. Apollo;
      c. Hammond;
      d. Nibco;
      e. Watts;
      f. Substitutions: See Section 016000 - Product Requirements.

2.08 IRON, GROOVED-END BALL VALVES
A. Class 200:
   1. CWP Rating: 600 psig.
   2. Body: Ductile iron; ASTM A536, Grade 65-45-12.
   3. Ends: Grooved.
   6. Ball: Type 304 stainless steel.
   7. Manufacturers:
      a. Anvil International; Gruvlock.
      b. Victaulic;
      c. Grinnell;
      d. Substitutions: See Section 016000 - Product Requirements.

2.09 IRON, GROOVED-END BUTTERFLY VALVES
A. CWP Rating: 175 psig (1200 kPa).
   1. Comply with MSS SP-67, Type I.
   2. Body: Coated ductile iron.
   4. Disc: Coated ductile iron.
   5. Disc Seal: EPDM.
   6. Manufacturers:
      a. Anvil International; Gruvlock.
      b. Victaulic;
      c. Grinnell;
      d. Substitutions: See Section 016000 - Product Requirements.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________

BYU MOTION PICTURE STUDIO
CHILLER PLANT

BYU STANDARD SPECIFICATION 2018 REV 1.0

GENERAL-DUTY VALVES FOR HVAC PIPING
2.10 **BRONZE LIFT CHECK VALVES**

A. Class 125:
   1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
   2. CWP Rating: 200 psig.
   3. Design: Vertical flow.
   5. Ends: Threaded.
   6. Disc (Type 1): Bronze.
   7. Manufacturers:
      a. Crane;
      b. Spirax Sarco;
      c. Astech Valve Co.;
      d. Substitutions: See Section 016000 - Product Requirements.

2.11 **BRONZE SWING CHECK VALVES**

A. Class 125: CWP Rating: 200 psig (1380 kPa).
   1. Comply with MSS SP-80, Type 3.
   2. Body Design: Horizontal flow.
   4. Ends: Threaded.
   5. Disc: Bronze.
   6. Manufacturers:
      a. Apollo;
      b. Nibco;
      c. Crane;
      d. Milwaukee;
      e. Substitutions: See Section 016000 - Product Requirements.

2.12 **IRON, FLANGED END SWING CHECK VALVES**

A. Class 125: CWP Rating: 200 psig (1380 kPa) with Metal Seats.
   1. Comply with MSS SP-71, Type I.
   2. Design: Clear or full waterway with flanged ends.
   3. Body: Gray iron with bolted bonnet in accordance with ASTM A126.
   4. Trim: Bronze.
   5. Disc Holder: Bronze.
   6. Disc: PTFE or TFE.

B. Manufacturers:
   1. Milwaukee;
   2. Apollo;
   3. Nibco;
   4. Crane;
   5. Mueller;

2.13 **IRON SWING CHECK VALVES WITH CLOSURE CONTROL**

A. Class 125:
   1. Comply with MSS SP-71, Type I.
   2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
   3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
   4. Body Design: Clear or full waterway.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
5. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Trim: Bronze.
9. Closer Control: Factory installed, exterior lever, and spring or weight.
10. Manufacturers:
   a. Nibco;
   b. American;
   c. Val-Matic;
   d. Mueller;
   e. Substitutions: See Section 016000 - Product Requirements.

2.14 IRON, GROOVED-END SWING CHECK VALVES
A. 300 CWP:
   1. 2 NPS to 8 NPS.
   2. 10 NPS to 12 NPS.
   3. CWP Rating: 300 psig.
   5. Seal: EPDM or Nitrile.
   6. Disc: Ductile iron.
   7. Coating: Black, non-lead paint.
   8. Manufacturers:
      a. Grinnell;
      b. Anvil International; Gruvlock.
      c. Victaulic;
      d. Substitutions: See Section 016000 - Product Requirements.

2.15 IRON, CENTER-GUIDED CHECK VALVES
A. Class 125, Compact-Wafer:
   1. Comply with MSS SP-125.
   2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
   3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
   5. Metal Seat: Bronze.
   6. Manufacturers:
      a. Metraflex;
      b. Keckley,
      c. Mueller,
      d. DeZurik;
      e. Crispin;
      f. Substitutions: See Section 016000 - Product Requirements.

B. Class 125, Globe:
   1. Comply with MSS SP-125.
   2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
   3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
   5. Style: Spring loaded.
   7. Metal Seat: Bronze.
   8. Manufacturers:
      a. Metraflex;

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
b. Keckley;
c. Mueller;
d. DeZurik;
e. Crispin;
f. Substitutions: See Section 016000 - Product Requirements.

2.16 BRONZE GATE VALVES
A. Non-Rising Stem (NRS) or Rising Stem (RS):
   1. Comply with MSS SP-80, Type I.
   4. Ends: Threaded or solder joint.
   5. Stem: Bronze.
   7. Packing: Asbestos free.
   8. Handwheel: Malleable iron or bronze.
   9. Manufacturers:
      a. Nibco;
      b. Crane;
      c. Apollo;
      d. Milwaukee;
   e. Substitutions: See Section 016000 - Product Requirements.

2.17 IRON GATE VALVES
A. NRS or OS & Y:
   1. Comply with MSS SP-70, Type I.
   2. Class 125: 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
   8. Trim: Bronze.
   11. Manufacturers:
       a. Mueller;
       b. Nibco;
       c. Crane;
       d. Milwaukee;
   e. Substitutions: See Section 016000 - Product Requirements.

2.18 FLOW CONTROL VALVES
A. Construction: Brass or bronze body with union, venturi with temperature and pressure test plug on inlet and outlet.
   B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.
   C. Manufacturers:
      1. ITT Bell & Gossett;
      2. Taco, Inc.;
      3. IMI Flow Design;
      4. Gerund;

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
2.19 CHAINWHEELS
A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   2. Attachment: For connection to butterfly and globe valve stems.
   3. Sprocket Rim with Chain Guides: Ductile or cast iron.

PART 3 EXECUTION
3.01 EXAMINATION
A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
B. Verify valve parts to be fully operational in all positions from closed to fully open.
C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
D. Should valve be determined to be defective, replace with new valve.

3.02 INSTALLATION
A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
D. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.
   3. Orient plate-type and center-guided into horizontal or vertical position, between flanges.
E. Provide chainwheels on operators for valves where specified on drawings.

END OF SECTION
I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________

BYU STANDARD
SPECIFICATION 2018 REV 1.0

230523 - 12

GENERAL-DUTY VALVES FOR
HVAC PIPING
SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.

B. Related Sections:
   1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
   3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 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. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized 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.

2.2 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.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anvil International.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   d. FNW/Ferguson Enterprises
   e. GS Metals Corp.
   f. Hilti, Inc.insert manufacturer's name.
   h. Thomas & Betts Corporation.
   i. Tolco Inc.
   j. Unistrut; an Atkore International company.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
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.
7. Metallic Coating:
   a. Electroplated zinc.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International; a subsidiary of Mueller Water Products, Inc.
   b. Empire Industries, Inc.
   c. ERICO International Corporation.
   d. FNW/Ferguson Enterprises
   e. Haydon Corporation.
   f. NIBCO INC.
   g. PHD Manufacturing, Inc.
   h. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
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.
7. Coating:
   a. Zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
3. ERICO International Corporation.
5. PHS Industries, Inc.
6. Pipe Shields Inc.
7. Piping Technology & Products, Inc.
8. Rileco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.
B. Insulation-Insert Material for Cold Piping:
   1. Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

C. Insulation-Insert Material for Hot Piping:
   1. Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

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.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."

B. 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.

C. 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, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. 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.

K. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for **trapeze pipe hangers**.

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.

3.3 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**.

3.4 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in **Division 09**.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel **pipe hangers and supports** and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes **NPS 1/2 to NPS 30**.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes **NPS 4 to NPS 24**, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes **NPS 3/4 to NPS 36**, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24** if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes **NPS 1/2 to NPS 4**, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes **NPS 3/4 to NPS 8**.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 8**.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 3**.
12. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30**.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes **NPS 2-1/2 to NPS 36** if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30**, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes **NPS 2-1/2 to NPS 24**, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42** if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes **NPS 2 to NPS 24** if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes **NPS 2 to NPS 30** if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. 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.

J. 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 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install 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.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use **powder-actuated fasteners** instead of building attachments where required in concrete construction.

END OF SECTION 230529
SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE
   A. Provide engineered vibration isolation and restraint systems in accordance with the requirements of this section including design, engineering, materials, testing, inspections and reports.
   B. Mechanical equipment with moving parts shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure.
   C. All mechanical equipment, piping and ductwork shall be restrained as required by Federal, State and Local building codes to preserve the integrity of nonstructural building components during seismic events to minimize hazards to occupants and reduce property damage.

1.3 SUMMARY
   A. This Section includes the following:
      1. Elastomeric isolation pads.
      2. Elastomeric isolation mounts.
      3. Restrained elastomeric isolation mounts.
      4. Open-spring isolators.
      5. Housed-spring isolators.
      6. Restrained-spring isolators.
      8. Pipe-riser resilient supports.
      9. Resilient pipe guides.
     10. Air-spring isolators.
     11. Restrained-air-spring isolators.
     12. Elastomeric hangers.
     13. Spring hangers.
     15. Restraint channel bracings.
     17. Seismic-restraint accessories.
     18. Mechanical anchor bolts.
     19. Adhesive anchor bolts.
     20. Vibration isolation equipment bases.
22. Certification of seismic restraint designs.
23. Installation supervision.
24. Design of attachment of housekeeping pads.
25. All components requiring IBC compliance and certification.
26. All inspection and test procedures for components requiring IBC compliance.
27. Restraint of all mechanical equipment, pipe and ductwork, within, on, or outdoors of the building and entry of services to the building, up to but not including, the utility connection, is part of this Specification.
28. Seismic certification of equipment.

1.4 DEFINITIONS

C. ASCE: American Society of Civil Engineers
D. OSHPD: Office of Statewide Health Planning and Development for the State of California.
E. Ip: Importance Factor.
F. ESSENTIAL FACILITIES, (Occupancy Category IV, IBC-2012)

1. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.

G. LIFE SAFETY

1. All systems involved with fire protection, including sprinkler piping, jockey pumps, fire pumps, control panels, service water supply piping, water tanks, fire dampers, smoke exhaust systems and fire alarm panels.

2. All mechanical, electrical, plumbing or fire protection systems that support the operation of, or are connected to, emergency power equipment, including all lighting, generators, transfer switches and transformers.

3. All medical and life support systems.

4. Hospital heating systems and air conditioning systems for maintaining normal ambient temperature.

5. Automated supply, exhaust, fresh air and relief air systems on emergency control sequence, including air handlers, duct, dampers, etc., or manually-operated systems used for smoke evacuation, purge or fresh air relief by the fire department.

6. Heating systems in any facility with Occupancy Category IV, IBC-2009 where the ambient temperature can fall below 32 degrees Fahrenheit.

H. HIGH HAZARD
1. All gases or fluids that must be contained in a closed system which are flammable or combustible. Any gas that poses a health hazard if released into the environment and vented Fuel Cells.

1.5 REFERENCE CODES AND STANDARDS

A. Codes and Standards: The following shall apply and conform to good engineering practices unless otherwise directed by the Federal, State or Local authorities having jurisdiction.

1. IBC
2. ASCE 7
3. NFPA 13 (National Fire Protection Association)

B. The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.


1.6 ISOLATOR AND RESTRAINT MANUFACTURER’S RESPONSIBILITIES:

A. Provide project specific vibration isolation and seismic restraint design prepared by a registered design professional in the state were the project is being constructed, and manufacturer certifications that the components are seismically qualified.

1. Provide calculations to determine restraint loads resulting from seismic forces as required by IBC, Chapter 16 and ASCE 7, latest editions. Seismic calculations shall be certified by an engineer licensed in the state where the project is being constructed.

B. Provide installation instructions and shop drawings for all materials supplied under this section of the specifications.

1. Provide seismic restraint details with specific information relating to the materials, type, size, and locations of anchorages; materials used for bracing; attachment requirements of bracing to structure and component; and locations of transverse and longitudinal sway bracing and rod stiffeners.
2. Provide seismic bracing layout drawings indicating the location of all seismic restraints.
Each piece of rotating isolated equipment shall be tagged to clearly identify quantity and size of vibration isolators and seismic restraints.

C. Provide, in writing, the special inspection requirements for all Designated Seismic Systems as indicated in Chapter 17 of the IBC.

D. Provide training for installation, operation and maintenance of isolation and restraint systems.

1.7 PERFORMANCE REQUIREMENTS

A. Flood-Restraint Loading: Per the structural drawings and specifications.

B. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: Per the structural drawings and specifications.
   2. Assigned Occupancy Category as Defined in the IBC: Per the structural drawings and specifications.

   a. Component Importance Factor: 1.5.
      1) Life safety components required to function after an earthquake.
      2) Components containing hazardous or flammable materials in quantities that exceed the exempted amounts for an open system listed in Chapter 4.
      3) For structures with an Occupancy Category IV, components needed for continued operation of the facility or whose failure could impair the continued operation of the facility.
      4) Storage racks in occupancies open to the general public (e.g., warehouse retail stores).

   b. Component Importance Factor: 1.0.
      1) All other components

   c. Component Response Modification Factor: Per the structural drawings and specifications.

   d. Component Amplification Factor: Per the structural drawings and specifications.

   3. Design Spectral Response Acceleration at Short Periods: Per the structural drawings and specifications.

   4. Design Spectral Response Acceleration at 1-Second Period: Per the structural drawings and specifications.

1.8 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Submittals shall include catalog cut sheets and installation instructions for each type of anchor and seismic restraint used on equipment or components being isolated and/or restrained.
   2. Submittals for mountings and hangers incorporating springs shall include spring diameter and free height, rated load, rated deflection, and overload capacity for each vibration isolation device.
   3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.

b. Annotate to indicate application of each product submitted and compliance with requirements.

4. 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.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. “Basis for Design” report: Statement from the registered design professional that the design complies with the requirements of the ASCE 7-05 Chapter 13, IBC 2009 chapter 1912 and ACI 318. In addition, the basis for compliance must also be noted, as listed below:

   a. Project specific design documentation prepared and submitted by a registered design professional (ASCE 7, 13.2.1.1)
   b. Submittal of the manufacturer’s certification that the isolation equipment is seismically qualified by:
   c. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
   d. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
   e. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. Seismic restraint load ratings must be certified and substantiated by testing or calculations under direct control of a registered professional engineer. Copies of testing and calculations must be submitted as part of submittal documents. OSHPD pre-approved restraint systems are exempt from this requirement if their pre-approval is current and based upon the IBC 2009 (i.e. OPA-07 pre-approval numbers).

3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

5. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

6. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

7. **Seismic**-Restraint Details:
   a. Design Analysis: To support selection and arrangement of **seismic** restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Preapproval and Evaluation Documentation: By an *evaluation service member* of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.9 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

1. Submittal drawings and calculations must be stamped by a registered professional engineer in the State where the project is being constructed who is responsible for the seismic restraint design.

2. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges. Concrete anchor locations shall not be near edges, stress joints, or an existing fracture. All bolts shall be ASTM A307 or better.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control test reports.
1.10 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.11 SEISMIC CERTIFICATION OF EQUIPMENT

A. Component Importance Factor. All plumbing and mechanical components shall be assigned a component importance factor. The component importance factor, $I_p$, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, $I_p$, equal to 1.0.

C. For equipment or components where $I_p = 1.0$.

1. Submit manufacturer’s certification that the equipment is seismically qualified by:

a. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
b. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. The equipment and components listed below are considered rugged and shall not require Special Seismic Certification:

a. Valves (not in cast-iron housings, except for ductile cast iron).
b. Pneumatic operators.
c. Hydraulic operators.
d. Motors and motor operators.
e. Horizontal and vertical pumps (including vacuum pumps).
f. Air compressors
g. Refrigerators and freezers.
h. Elevator cabs.
i. Underground tanks.
j. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE 7.

3. Rugged equipment and components in this section are for factory assembled discrete equipment and components only and do not apply to site assembled or field assembled equipment or equipment anchorage. The list is based in part on OSHPD Code Application Notice 2-1708A.5.

D. Special Certification requirements for Designated Seismic Systems (i.e. Ip = 1.5): Seismic Certificates of Compliance supplied by manufacturers shall be submitted for all components that are part of Designated Seismic Systems. In accordance with the ASCE 7, certification shall be via one of the following methods:

1. For active mechanical and electrical equipment that must remain operable following the design earthquake:
   a. Testing as detailed by part C.1.b above.
   b. Experience data as detailed by part C.1.c above.
   c. Equipment that is considered “rugged” per part C.2 above.

2. Components with hazardous contents shall be certified by the manufacturer as maintaining containment following the design earthquake by:
   a. Testing as detailed by part C.1.b above.
   b. Experience data as detailed by part C.1.c above.
   c. Engineering analysis utilizing dynamic characteristics and forces. Tanks (without vibration isolators) designed by a registered design professional in accordance with ASME Boiler and Pressure Vessel Code, and satisfying the force and displacement requirements of Sections 13.3.1 and 13.3.2 of ASCE 7 having an importance factor, Ip = 1.0 shall be considered to satisfy the Special Seismic Certification requirements on the basis of ASCE 7 Section 13.6.9.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Elastomeric Isolation Pads P1:

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

C. Double-Deflection, Elastomeric Isolation Mounts M1:

1. Mounting Plates:
   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded, or with threaded studs or bolts.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Restrained Elastomeric Isolation Mounts M2:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

E. Spring Isolators S1: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

VIBRATION AND SEISMIC CONTROLS FOR HVAC

F. Restrained Spring Isolators S2: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Baseplates shall limit floor load to 500 psig.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Restrained Spring Isolators S3: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric pad: For high frequency absorption at the base of the spring.

H. Elastomeric Hangers H1:

1. Description: Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods
   a. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.
I. Spring Hangers H2: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and Insert in Compression.
   a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop H3: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and insert in Compression and vertical limit stop.
   a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support R1:

1. Description: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene.
   a. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   b. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.
L. Resilient Pipe Guides **R2**:  
   1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene. 
      a. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

M. Horizontal Thrust Restraints **T1**: Modified specification S2 isolator.  
   1. Horizontal thrust restraints shall consist of a modified specification S2 spring mounting. Restraint springs shall have the same deflection as the isolator springs.  
   2. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of 1/4" movement from stop to maximum thrust.  
   3. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure.  
   4. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS  
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
   1. Amber/Booth Company, Inc.  
   2. CalDyn (California Dynamics Corporation).  
   3. ISAT (International Seismic Application Technology).  
   5. Mason Industries.  
   6. Vibro-Acoustics  
   7. VMC (Vibration Mountings & Controls, Inc.)  
B. Restrained Vibration Isolation Roof-Curb Rails: **RC1**:  
C. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.  
D. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic forces.  
E. Lower Support Assembly: The lower support assembly shall be a formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.  
F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are...
accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. **Restrained Spring Isolators**: Freestanding, steel, open-spring isolators with seismic and wind restraint.
   a. **Housing**: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
   b. **Outside Spring Diameter**: Not less than 80 percent of the compressed height of the spring at rated load.
   c. **Minimum Additional Travel**: 50 percent of the required deflection at rated load.
   d. **Lateral Stiffness**: More than 80 percent of rated vertical stiffness.
   e. **Overload Capacity**: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. **Snubber Bushings**: All-directional, elastomeric snubber bushings at least 1/4 inch-thick.

H. **Water Seal**: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

I. All roof curbs shall be at least 8-inches (MIN) above the roof membrane.

### 2.3 VIBRATION ISOLATION EQUIPMENT BASES

A. **Manufacturers**: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. **Steel Bases and Rails SB1**: Factory-fabricated, welded, structural-steel bases and rails.

1. **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.

2. **Structural Steel**: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases 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.

1. Design Requirements: Lowest possible mounting height with not less than 2-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.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases 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.

4. 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.

2.4 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. Channel Support System: MFMA-4, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Cables located in exterior or other wet locations such as wash-down areas shall be stainless steel.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

G. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

H. 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.

I. 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.

J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

K. 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. Minimum length of eight times diameter.

L. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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.

M. All post installed anchors utilized in the seismic design must be qualified for use in cracked concrete and approved for use with seismic loads.

N. Expansion anchors shall not be used for anchorage of equipment with motors rated over 10 HP with the exception of undercut expansion anchors. Spring or internally isolated equipment are exempt from this requirement.

O. All beam clamps utilized for vertical support must also incorporate retention straps.

P. All seismic brace arm anchorages to include concrete anchors, beam clamps, truss connections, etc., must be approved for use with seismic loads.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and tested equipment before shipping.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-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.

3.2 COORDINATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 4,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.

C. Housekeeping pads shall have adequate space to mount equipment and seismic restraint devices.

D. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure. Refer seismic restraint manufacturer’s written instructions.

E. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer’s written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer’s written instructions.
3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES and per the seismic restraint manufacturer’s design.

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 will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

C. Isolate all mechanical equipment 0.75 hp and over per the isolator and seismic restraint schedule and these specifications. Vibration isolators shall be selected in accordance with the equipment, pipe or duct weight distribution so as to produce reasonably uniform deflections.

D. All isolation materials and seismic restraints shall be of the same vendor and shall be selected and certified using published or factory certified data.

E. Installation of all vibration isolation materials, flexible connectors and supplemental equipment bases specified in this section shall be accomplished as per the manufacturer’s written instructions with mountings adjusted to level equipment. Any variance or non-compliance with the manufacturer’s instructions shall be reviewed and approved in writing by the manufacturer or corrected by the contractor in an approved manner.

F. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

G. Locate isolation hangers as near to the overhead support structure as possible.

H. No rigid connections between isolated components and the building structure shall be made that degrades the noise and vibration control system herein specified. “Building” includes, but is not limited to, slabs, beams, columns, studs and walls. “Components” includes, but is not limited to, mechanical equipment, piping and ducts.

I. Coordinate work with other trades to avoid rigid contact with the building.

J. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.
K. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

L. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor’s expense.

M. Use horizontal thrust restraints T1 to protect Air handling equipment and centrifugal fans against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight.

N. Isolated equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.

O. On completion of installation of all isolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.

P. All floor mounted isolated equipment shall be protected with specification M1, M2, S1, S2 or S3 isolator.

Q. Horizontal Pipe Isolation: All HVAC pumped water, pumped condensate, glycol, and refrigerant piping size 1-1/4” and larger within mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50’ or 100 pipe diameters from rotating equipment. For the first three (3) support locations from externally isolated equipment provide specification H2 or H3 hangers or specification S1, S2 or S3 mounts with the same deflection as equipment isolators (max 2”). All other piping within the equipment rooms shall be isolated with the same specification isolators with a 3/4” minimum deflection. Steam piping size 1-1/4” and larger which is within an equipment room and connected to rotating equipment shall be isolated for three (3) support locations from the equipment. Provide specification H2 or H3 hangers, or specification S1 or S2 mounts with the same deflection as equipment isolators but a minimum of ¾”.

R. Install full line size flexible pipe connectors at the inlet and outlet of each pump, cooling tower, condenser, chiller, coiling connections and where shown on the drawings. All connectors shall be suitable for use at the temperature, pressure, and service encountered at the point of installation and operation. End fitting connectors shall conform to the pipefitting schedule. Control rods or protective braid must be used to limit elongation to 3/8”. Flexible connectors shall not be required for suspended in-line pumps.

S. All plumbing pumped water, piping size 1-1/4” and larger within mechanical rooms shall be isolated the same as HVAC piping above. Isolators are not required for any plumbing pumped water, pumped condensate, and steam piping outside of mechanical rooms unless listed in the isolation schedule.

T. Pipe Riser Isolation: The operating weight of all variable temperature vertical pipe risers 1-1/4” and larger, requiring isolation where specifically shown and detailed on riser drawings shall be fully supported by specification M1, M2 or R1 supports. S1, S2, S3, H2 or H3 steel spring deflection isolators with minimum 3/4-inch minimum shall be in those locations where added deflection is required due to pipe expansion and contraction. Spring deflection shall be a
minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Height saving brackets used with isolators having 2.5” deflection or greater shall be of the precompression type to limit exposed bolt length. Specification R1 riser supports shall be installed near the center point of the riser to anchor the riser when spring isolation is used. Specification R2 riser guides may be used in conjunction with spring isolators per design calculations. Pipe risers up through 16” shall be supported at intervals of every third floor of the building. Pipe risers 18” and over, every second floor. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Horizontal take-offs and at upper and lower elbows shall be supported with spring isolators as required to accommodate anticipated movement. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist if installed per design proposed.

U. Where riser pipes pass through cored holes, core diameters shall be a maximum of 2” larger than pipe O.D. including insulation. Cored holes must be packed with resilient material or firestop as provided by other sections of this specification or local codes. Where seismic restraint is required specification isolator S3 shall support risers and provide longitudinal restraint at floors where thermal expansion is minimal and will not bind isolator restraints.

V. Duct Isolation: Isolate all duct work with a static pressure 2” W.C. and over in equipment rooms and to minimum of 50 feet from the fan or air handler. Use specification type H2 or H3 hangers or type S1 or S2 floor mounts.

3.5 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. On projects with Seismic Site Class A or B, seismic design or restraint is not required.

2. On projects with Seismic Design Category C: Components with an importance factor of 1.0 do not require seismic design or restraint.

3. 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.

4. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

5. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

6. Suspended Equipment: All suspended equipment that meets any of the following conditions requires seismic restraints as specified by the supplier:

   a. Rigidly attached to pipe or duct that is 75 lbs. and greater,
b. Items greater than 20 lbs and distribution systems weighing more than 5 lbs/lineal foot, with an importance factor of 1.0 hung independently or with flexible connections.
c. Possibility of consequential damage.
d. For importance factors greater than 1.0 all suspended equipment requires seismic restraint regardless of the above notes.
e. Wall mounted equipment weighing more than 20 lbs.
f. Exemptions:

1) Equipment weighing less than 20 lbs and distribution systems weighing less than 5 lbs/lineal foot, with an Ip = 1.0 and where flexible connections exist between the component and associated ductwork, piping or conduit.

7. Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified by the supplier:

a. Connections to or containing hazardous material,
b. With an overturning moment,
c. Weight greater than 400 lbs.
d. Mounted on a stand 4 ft. or more from the floor
e. Possibility of consequential damage.
f. For importance factors greater than 1.0 all base mounted items require seismic restraints regardless of the above notes.
g. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
h. Exemptions:

1) Floor or curb-mounted equipment weighing less than 400 lbs and not resiliently mounted, where the Importance Factor, Ip = 1.0, the components are mounted at 4 feet or less above a floor level, flexible connections between the components and associated ductwork, piping and conduit are provided and there is no possibility of consequential damage.

8. Roof Mounted Equipment:

a. To be installed on a structural frame, seismically rated roof curb, or structural curb frame mechanically connected to the structure. Items shall not be mounted onto sleepers or pads that are not mechanically and rigidly attached to the structure. Restraint must be adequate to resist both seismic and wind forces.
b. Roof curbs shall be installed directly to building structural steel or concrete roof deck and not to top of steel deck or roofing material.
c. Exemptions:

1) Curb-mounted mushroom, exhaust and vent fans with curb area less than nine square feet are excluded.

9. Rigid Mounted Equipment:

a. Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.
b. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.

c. Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.

10. Vibration Isolated Equipment:

a. Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.

b. Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8” gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.

B. 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.

C. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

E. Installation and adjustment of all seismic restraints specified in this section shall be accomplished as per the manufacturer’s written instructions. Any deviation from the manufacturer’s instructions shall be reviewed and approved by the manufacturer.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.

4. Seismically restrain piping, with an Ip = 1.0, located in boiler rooms, mechanical equipment rooms and refrigeration equipment rooms that is 1¼” I.D. and larger.

5. Seismically restrain all other Ip = 1.0 piping 2½” diameter and larger.

6. Seismically restrain all Ip = 1.5 piping larger than 1” diameter.

7. Branch lines may not be used to brace main lines.

8. Exemptions:

a. All high deformability pipe 3” or less in diameter suspended by individual hanger rods where Ip = 1.0.

b. High deformability pipe or conduit in Seismic Design Category C, 2” or less in diameter suspended by individual hanger rods where Ip = 1.5.

c. High deformability pipe in Seismic Design Category D, E or F, 1” or less in diameter suspended by individual hanger rods where Ip = 1.5.

d. All clevis supported pipe runs installed less than 12” from the top of the pipe to the underside of the support point and trapeze supported pipe suspended by hanger rods having a distance less than 12” in length from the underside of the pipe support to the support point of the structure.

e. Piping systems, including their supports, designed and constructed in accordance with ASME B31.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

VIBRATION AND SEISMIC CONTROLS FOR HVAC

f. Piping systems, including their supports, designed and constructed in accordance with NFPA, provided they meet the force and displacement requirements of Section 13.3.1 and 13.3.2 (ASCE 7).

G. Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

H. Install flexible piping connectors 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.

I. Where pipe sizes reduce below dimensions required for seismic, the final restraint shall be installed at the transition location.

J. Restraint Spacing For Piping: Sizes shown are maximum. Actual spacing determined by calculation.
   1. For non-ductile piping (e.g., cast iron, PVC) space transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
   2. For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
   3. For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.
   4. For all other ductile piping see Table “A” below

K. Seismic Restraint of Ductwork: Seismically restrain per specific code requirements, all ductwork listed below (unless otherwise indicated on the drawings), using seismic cable restraints: (Ductwork not meeting criteria listed below is to be “Exempt”)
   1. Restrain rectangular ductwork with cross sectional area of 6 square feet or larger. Duct with an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
   2. Restrain round ducts with diameters of 28” or larger. Duct with an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
   3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
   4. Duct must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze. Additional reinforcing is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.
   5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
   6. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
   7. If ducts are supported by angles, channels or struts, ducts shall be fastened to it at seismic brace locations in lieu of duct reinforcement.
   8. All ductwork weighing more than 17 lb/ft.
9. Exemptions:
   a. Duct runs supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. This exemption does not apply to ducts with an importance factor of 1.5.

10. See Table “A” below for restraint spacing.

L. Exemptions do not apply for:

   1. Life Safety or High Hazard Components
      a. Including gas, fire protection, medical gas, fuel oil and compressed air needed for the continued operation of the facility or whose failure could impair the facility’s continued operation, Occupancy Category IV, IBC-2009 as listed in Section 1.3 B regardless of governing code for HVAC, Plumbing, Electrical piping or equipment. (A partial list is illustrated.) High Hazard is additionally classified as any system handling flammable, combustible or toxic material. Typical systems not excluded are additionally listed below.

   2. Piping
      a. Fuel oil, gasoline, natural gas, medical gas, steam, compressed air or any piping containing hazardous, flammable, combustible, toxic or corrosive materials. Fire protection standpipe, risers and mains. Fire Sprinkler Branch Lines must be end tied.

   3. Duct
      a. Smoke evacuation duct or fresh air make up connected to emergency system, emergency generator exhaust, boiler breeching or as used by the fire department on manual override.

   4. Equipment
      a. Previously excluded non life safety duct mounted systems such as fans, variable air volume boxes, heat exchangers and humidifiers having a weight greater than 75 lbs require independent seismic bracing.

M. Spacing Chart For Suspended Components:
N. Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.

O. Where duct sizes reduce below dimensions required for seismic restraint the final restraint shall be installed at the transition location.

P. Install cables so they do not bend across edges of adjacent equipment or building structure.

Q. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

R. 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.

S. 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.

T. Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.

U. 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 structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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.

---

Table “A” Seismic Bracing
(Maximum Allowable Spacing Shown- Actual Spacing to Be Determined by Calculation)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>On Center Transverse</th>
<th>On Center Longitudinal</th>
<th>Change Of Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct</td>
<td>30 Feet</td>
<td>60 Feet</td>
<td>4 Feet</td>
</tr>
<tr>
<td>All Sizes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Threaded, Welded, Soldered Or Grooved</th>
</tr>
</thead>
<tbody>
<tr>
<td>To 16”</td>
</tr>
<tr>
<td>18” – 28”</td>
</tr>
<tr>
<td>30” – 40”</td>
</tr>
<tr>
<td>42” &amp; Larger</td>
</tr>
</tbody>
</table>
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.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. 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 Division 23 Section “Hydronic Piping” for piping flexible connections.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. A representative of the vibration isolation system manufacturer shall review the project installation and provide documentation indicating conformance to vibration isolation design intent

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

1. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer’s representative’s final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

3.8 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

1. Adjust active height of spring isolators.

C. 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.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

<table>
<thead>
<tr>
<th>EQUIPMENT ISOLATION SCHEDULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A'</td>
</tr>
</tbody>
</table>

VIBRATION AND SEISMIC CONTROLS FOR HVAC 230548 - 25
## BYU MOTION PICTURE STUDIO
### CHILLER PLANT

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CRITICAL (35'-50' SPAN)</th>
<th>UPPER STORY (20'-35' SPAN)</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ISOLATOR TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ISOLATOR TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ISOLATOR TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ISOLATOR TYPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
</tbody>
</table>

### EQUIPMENT (1)

#### AIR HANDLING UNITS

**FLOOR MOUNTED**

- **UP TO 15 HP**
  - S3: 1.5
  - S3: 0.75
- **20 HP & OVER**
  - S3: 2.5
  - SB1: S3: 1.5

**SUSPENDED**

- **UP TO 15 HP**
  - H3: 1.75
- **20 HP & OVER**
  - H3: 2.5

#### HIGH PRESSURE FAN SECTIONS

- **UP TO 30 HP**
  - S1: 2.5
  - IB1: S3: 1.5
  - IB1: S3: 2.5
  - IB1: S3: 1.5
- **40 HP & OVER**
  - S1: 3.5
  - IB1: S3: 2.5

#### CENTRIFUGAL FANS

**CL. I & II UP TO 54'-112' W.D.**

- **UP TO 15 HP**
  - S3: 1.5
  - SB1: S3: 0.75
- **20-50 HP**
  - S1: 2.5
- **60 HP & OVER**
  - S1: 3.5

**CL. I & II 60' W.D. & OVER CL. III FANS**

- **UP TO 15 HP**
  - S3: 1.5
- **20-50 HP**
  - S1: 2.5
- **60 HP & OVER**
  - S1: 3.5

#### AXIAL FLOW FANS

**FLOOR MTD.**

- **UP TO 15 HP**
  - S3: 1.5
- **20 HP & OVER**
  - S1: 3.5
- **SUSPENDED**
  - **UP TO 15 HP**
    - H3: 1.75
  - **20 HP & OVER**
    - H3: 2.5

#### VENT (UTILITY SETS)

**FLOOR MTD.**

- S3: 1.5
- **SUSPENDED**
  - H3: 1.75

#### CABINET FANS, FANS SECTIONS

**FLOOR MTD.**

- **UP TO 15 HP**
  - S3: 1.5
- **20 HP & OVER**
  - S1: 2.5
- **SUSPENDED**
  - **UP TO 15 HP**
    - H3: 1.75
  - **20 HP & OVER**
    - H3: 2.5

#### PUMPS

**FLOOR MTD.**

- **UP TO 15 HP**
  - S3: 0.75
- **7-112 HP & OVER**
  - S3: 1.5
- **SUSPENDED IN LINE**
  - H3: 1.75

#### REFRIGERATION UNITS

**RECIPROCATING COMPRESSORS**

- S1: 2.5
  - IB1: S3: 1.5
  - IB1: S3: 0.75
- **RECIPROCATING COMP. UNITS & CHILLERS**
  - S1: 2.5
  - IB1: S3: 1.5
  - IB1: S3: 0.75
- **HERMETIC CENTRIFUGALS**
  - S3: 2.5
  - IB1: S3: 1.5
  - P1: 0.15
- **OPEN CENTRIFUGALS**
  - S1: 2.5
  - IB1: S3: 1.5
  - IB1: P1: 0.15
- **ABSORPTION MACHINES**
  - S3: 1.5
  - IB1: S3: 0.75
  - P1: 0.15

#### AIR COMPRESSORS

**TANK TYPE (HORIZONTAL TANK)**

- S1: 2.5
  - IB1: S3: 1.5
  - IB1: S3: 0.75
- **TANK TYPE (VERTICAL TANK)**
  - S1: 2.5
  - IB1: S3: 1.5
  - IB1: S3: 0.75

#### COOLING TOWERS & CLOSED CIRCUIT COOLERS

**UP TO 500 TONS**

- S3: 2.5
  - S3: 0.75
  - P1: 0.15
- **OVER 5000 TONS**
  - S3: 4.5
  - S3: 2.5
  - P1: 0.15

#### AIR COOLED CONDENSERS

- **UP TO 50 TONS**
  - S3: 1.5
  - S3: 0.75
  - P1: 0.15
- **OVER 50 TONS**
  - S3: 2.5
  - S3: 1.5
  - P1: 0.15

#### ROOF-TOP AIR CONDITIONING UNITS

**REQUIRING WEATHER SEAL**

- **UP TO 5000 CFM (12 TON)**
  - S1: 1.5
  - RC1: S1: 0.75
- **OVER 5000 CFM (12 TON)**
  - S3: 2.5
  - RC1: S3: 1.5
- **OTHER TYPES**
  - **UP TO 25 TONS**
    - S3: 1.5
  - **OVER 25 TONS**
    - S3: 2.5

**BOILER (PACKAGE TYPE)**

- **ALL SIZES**
  - S3: 1.5
  - S3: 0.75
  - P1: 0.15

#### ENGINE DRIVEN GENERATORS

**UP TO 60 HP**

- S1: 2.5
  - IB1: S3: 1.5
  - IB1: S3: 0.75
- **75 HP & OVER**
  - S1: 3.5
  - IB1: S3: 2.5
  - IB1: S3: 0.75

---

**NOTES:**

VIBRATION AND SEISMIC CONTROLS FOR HVAC

230548 - 26
BYU MOTION PICTURE STUDIO  
CHILLER PLANT

1) Thrust restraints required on all high-pressure fan section, suspended axial-flow fans and on floor-mounted axial fans operating at 3.0” S.P. or greater.

END OF SECTION 230548
SECTION 230550 - OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All pertinent sections of Division 21, 22, & 23 Mechanical General Requirements, are part of the work of this Section. Division 1 is part of this and all other sections of these specifications.

1. Testing and Balancing is specified in section 230594.
2. Training and Instructions to Owner’s Representative is specified in section 230100.

1.2 SCOPE OF WORK

A. Submission of Operating and Maintenance Manuals complete with Balancing reports. (Coordinate with Division 1).

B. Coordination of work required for system commissioning.

C. Provide a hard copy and an electronic copy on CD of the O and M manual fully searchable in PDF format.

1.3 SUBMITTALS

A. Submit product data in accordance with Division 1 and Section 230100. Submit the following:

2. Hard copy and an electronic copy on CD of the O and M manual fully searchable in PDF format. Both the hard copy and the electronic copy are to be fully indexed. The electronic copy shall also have a linked index.

PART 2 - PRODUCTS

2.1 O & M MANUALS

A. The operating and maintenance manuals shall be as follows:

1. Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows: (coordinate with Division 01 )

OPERATING AND MAINTENANCE MANUAL
PART 3 - EXECUTION

3.1 OPERATING AND MAINTENANCE MANUALS:

A. Work under this section shall be performed in concert with the contractor performing the system testing and balancing. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.

B. The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.

C. The manuals shall include air and water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owner’s representatives.

An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall be include the following:

SYSTEM DESCRIPTIONS
START-UP PROCEDURE AND OPERATION OF SYSTEM
MAINTENANCE AND LUBRICATION TABLE
OPERATION AND MAINTENANCE BULLETINS
AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.
AIR AND WATER SYSTEM BALANCING REPORTS
EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES
BYU MOTION PICTURE STUDIO
CHILLER PLANT

SYSTEM COMMISSIONING REPORTS
EQUIPMENT START-UP CERTIFICATES

END OF SECTION 230550
SECTION 230553 - IDENTIFICATION FOR HVAC, PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Label all plumbing, heating, air conditioning, automatic temperature control valves, equipment (excluding thermostats and relay), and distribution systems.
   B. Label all electrical switches and starters for all mechanical equipment.
   C. Label all fire dampers, fire smoke dampers, smoke damper access doors.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   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.

1.4 COORDINATION
   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.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS
   A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, and having predrilled holes for attachment hardware, 1/16 inch thick.

2. Letter Color:
   a. Black.
   b. Fire/Smoke Damper Access Door: Red

3. Background Color:
   a. White.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel;
   a. Rivets or self-tapping screws

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content:
   1. Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
   2. List capacity specified, actual capacity and area or zone served.
   3. Note operating conditions, including head or static pressure, RPM, motor horsepower at design conditions, area or zone served, name of lubricant frequency of lubrication.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction. The arrow shall point away from the lettering. Use a double-headed arrow if the flow can be in either direction.
a. Shaft Arrow Size:
   1) Piping 3-inch or larger: 2-inches long and 1-inch wide.
   2) Piping 2-1/2” or smaller: 2-inches long and ½ - inch wide.

2. Lettering Size:
   a. Piping 3-inch or larger: 2-inches high.
   b. Piping 2-1/2” to 1-1/4”: 1-inch high.
   c. Piping 1” or smaller: ½ - inch high.

3. Piping shall be identified with colors per Pipe Label Color Schedule (See Below).

2.3 DUCT LABELS

A. Color code all accessible ductwork and identify with wording and arrows every 50 feet, at each riser, at each junction, at each access door, at each wall penetration and where required to easily identify the medium transported.

B. Material and Thickness: Painted or stenciled, self-adhesive or glue on are acceptable.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Letter Size:
   1. 2 inch.

E. Fasteners: Stainless-steel;
   1. Rivets or self-tapping screws

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Shaft Arrow Size: 2-inches long and 1-inch wide.
   3. Lettering Size: At least 2 inches high.

2.4 VALVE TAGS

A. Valve Tags: Engraved with minimum 1/8-inch letters for piping system abbreviation and minimum 1/8-inch numbers.

   1. Tag Material, predrilled or stamped holes for attachment hardware, minimum thickness:
      a. Brass, 0.051-inch
   2. Tag Size: 1” x 3”
   3. Fasteners: Brass;
      a. Beaded chain; or S-hook

B. Provide valve tags which include the following minimum information:
1. Normal Position
2. Duty

C. Identify tag numbers as follows:

<table>
<thead>
<tr>
<th>Valve Tags</th>
<th>Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-99</td>
<td>HW</td>
</tr>
<tr>
<td>100</td>
<td>CHW</td>
</tr>
<tr>
<td>200</td>
<td>CW</td>
</tr>
<tr>
<td>300</td>
<td>DWC &amp; DWH</td>
</tr>
<tr>
<td>400</td>
<td>FIRE</td>
</tr>
<tr>
<td>500</td>
<td>AIR</td>
</tr>
<tr>
<td>600</td>
<td>DEM W</td>
</tr>
<tr>
<td>700</td>
<td>GHRW</td>
</tr>
</tbody>
</table>

D. Valve Schedules:

1. For each piping system, on 8-1/2-by-11-inch bond paper, tabulate
   a. Valve number.
   b. Piping system.
   c. System abbreviation (as shown on valve tag).
   d. Location of valve (room or space).
   e. Normal-operating position (open, closed, or modulating).
   f. Variations for identification.
   g. Mark valves for emergency shutoff and similar special uses.

2. Valve-tag schedule:
   a. Shall be included in operation and maintenance data.

2.5 PANEL IDENTIFICATION

A. Provide all panel devices on panel faces with engraved black face formica with white engraved lettering labels.

B. Provide all internal panel components with engraved black face formica labels with white engraved lettering. Fasten label beneath each device.

C. Numerically or alphabetically code all panel wiring and tubing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
3.2 EQUIPMENT LABEL INSTALLATION
   A. Install or permanently fasten labels on each major item of mechanical equipment.
   B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION
   A. Piping Color-Coding: Per Pipe Label Color Schedule (See Below).
   B. 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 branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
      4. At access doors, manholes, and similar access points that permit view of concealed piping.
      5. Near major equipment items and other points of origination and termination.
      6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment. Locate at each riser, each junction, each access door, and each wall penetration.
   C. Pipe Label Color Schedule: (See Below).

3.4 DUCT LABEL INSTALLATION
   A. Install plastic-laminated duct labels with permanent adhesive on air ducts.
   A. Color code all accessible duct and identify with wording and arrows every 50 feet, at each riser, at each junction, at each access door, at each wall penetration and where required to easily identify the medium transported.

3.5 VALVE-TAG INSTALLATION (See Drawing Schedules.)
   A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.6 WARNING-TAG INSTALLATION
   A. Write required message on, and attach warning tags to, equipment and other items where required.
<table>
<thead>
<tr>
<th>Medium in Pipe or Duct</th>
<th>Banding Color</th>
<th>Identifying Lettering</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water Supply</td>
<td>One Blue</td>
<td>Chilled Water Supply</td>
<td>CHWS</td>
</tr>
<tr>
<td>Chilled Water Return</td>
<td>Two Blue</td>
<td>Chilled Water Return</td>
<td>CHWR</td>
</tr>
<tr>
<td>Domestic Cold Water</td>
<td>One Green</td>
<td>Domestic Cold Water</td>
<td>DWC</td>
</tr>
<tr>
<td>Domestic Cold Water Return</td>
<td>One Green</td>
<td>Domestic Soft Cold Water</td>
<td>DSCW</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>One Yellow, Two Green</td>
<td>Domestic Hot Water</td>
<td>DWH</td>
</tr>
<tr>
<td>Domestic Hot Water Return</td>
<td>One Yellow, Two Green</td>
<td>Domestic Hot Water Return</td>
<td>DWHR</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>Red</td>
<td>Fire Protection</td>
<td>FIRE</td>
</tr>
<tr>
<td>Deionized Water</td>
<td>One Grey</td>
<td>Deionized Water</td>
<td>DI</td>
</tr>
<tr>
<td>Pure Water</td>
<td>Two Grey</td>
<td>Pure Water</td>
<td>ROW</td>
</tr>
<tr>
<td>High Temp Heating Water Supply</td>
<td>One Yellow, Two Orange</td>
<td>High Temp Heating Water Supply</td>
<td>HTHWS</td>
</tr>
<tr>
<td>High Temp Heating Water Return</td>
<td>One Yellow, One Orange</td>
<td>High Temp Heating Water Return</td>
<td>HTHWR</td>
</tr>
<tr>
<td>Heating Water Supply (Bldg. Heat)</td>
<td>One Yellow, Two Green</td>
<td>Heating Water Supply (Bldg. Heat)</td>
<td>BHWS</td>
</tr>
<tr>
<td>Heating Water Return (Bldg. Heat)</td>
<td>One Yellow, One Orange</td>
<td>Heating Water Return (Bldg. Heat)</td>
<td>BHWR</td>
</tr>
<tr>
<td>Roof Drain</td>
<td>Green</td>
<td>Roof Drain</td>
<td>R.D</td>
</tr>
<tr>
<td>Drain</td>
<td></td>
<td>Drain</td>
<td></td>
</tr>
<tr>
<td>Control Air</td>
<td></td>
<td>Control Air</td>
<td>C Air</td>
</tr>
<tr>
<td>Compressed Air</td>
<td></td>
<td>Compressed Air</td>
<td>C.A.</td>
</tr>
<tr>
<td>Cold Air Duct</td>
<td></td>
<td>Cold Air Duct</td>
<td>(Unit Served)</td>
</tr>
<tr>
<td>Hot Air Duct</td>
<td></td>
<td>Hot Air Duct</td>
<td>(Unit Served)</td>
</tr>
<tr>
<td>Return Air Duct</td>
<td></td>
<td>Return Air Duct</td>
<td>(Unit Served)</td>
</tr>
<tr>
<td>Exhaust Air Duct</td>
<td></td>
<td>Exhaust Air Duct</td>
<td>(Unit Served)</td>
</tr>
<tr>
<td>Fire Smoke, Fire Smoke Damper</td>
<td></td>
<td>Fire, Smoke, Access Doors</td>
<td>AD - Red</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire/Smoke Damper</td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION 230553
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
   2. Balancing Hydronic Piping Systems:
      a. Primary-secondary hydronic systems.
   3. Various HVAC Equipment.
      a. Motors.
      b. Chillers.

1.3 DEFINITIONS

C. TAB: Testing, adjusting, and balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.
E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within the following number of days of the Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article;
   1. 30 days.
B. Certified TAB reports.
C. Instrument calibration reports, to include the following:
1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB and shall be the same as the TAB Contractor.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician and shall be the same as the TAB Contractor.

B. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by:
   1. Architect.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT 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.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on the following distribution systems have been satisfactorily completed:
   1. Air and water.
PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, **engage one of the following:**

1. Bonneville Test and Balance
2. BTC Service.
3. Certified Test & Balance.
5. RS Analysis.
6. Test & Balance Inc.
7. Payson Sheetmetal.
8. QT&B Inc.

3.2 EXAMINATION

A. 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.

B. Examine systems for installed 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 accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. 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.

E. Examine:
   1. Ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in: 
      a. **Section 233113 "Metal Ducts"**
   2. Verify ceiling plenums and underfloor air plenums used for supply, return or relief air are properly separated from adjacent areas.
   3. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. 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.
   2. 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.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. 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.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.
3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in this section and:
   1. AABC's "National Standards for Total System Balance"

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, 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 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "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)**.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. 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.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."
3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from one of the following entities for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance:

   a. Architect.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
BYU MOTION PICTURE STUDIO
CHILLER PLANT

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from the following entity and comply with requirements in Section 232123 "Hydronic Pumps."
      1) [Architect].

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.10 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser 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.
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.

3.12 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: **Plus or minus 10 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**.

### 3.13 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, 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. Status Reports: Prepare progress reports on the following interval to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors;

1. Weekly.

### 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.

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.
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 contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
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. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. 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.

E. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangement and class.
      g. Sheave make, size in inches, and bore.
      h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

   2. Motor Data:
      a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

F. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

   1. Report Data:
      a. System and air-handling-unit number.
      b. Location and zone.
      c. Traverse air temperature in deg F.
      d. Duct static pressure in inches wg.
      e. Duct size in inches.
      f. Duct area in sq. ft.
      g. Indicated air flow rate in cfm.
      h. Indicated velocity in fpm.
      i. Actual air flow rate in cfm.
      j. Actual average velocity in fpm.
      k. Barometric pressure in psig.

G. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model number and serial number.
      f. Water flow rate in gpm.
      g. Water pressure differential in feet of head or psig.
      h. Required net positive suction head in feet of head or psig.
      i. Pump rpm.
      j. Impeller diameter in inches.
      k. Motor make and frame size.
      l. Motor horsepower and rpm.
      m. Voltage at each connection.
      n. Amperage for each phase.
2. Test Data (Indicated and Actual Values):

   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

H. Instrument Calibration Reports:

   1. Report Data:

      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
   2. Check the following for each system:

      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

   1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by:

      a. Architect.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of:
   a. Architect.
3. The following entity shall 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:
   a. Architect.
4. 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."
5. 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.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   1. 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 contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. 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.

END OF SECTION 230593
SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes insulating the following HVAC piping systems:
      1. Chilled-water piping.

1.3 DEFINITIONS:
   A. Refer to Section 230500 “Common Work Results for HVAC”.

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

1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified Installer.
   B. Material Test Reports: From a qualified testing agency acceptable to authorities having
      jurisdiction indicating, interpreting, and certifying test results for compliance of insulation
      materials, sealers, attachments, cements, and jackets, with requirements indicated. Include
      dates of tests and test methods employed.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.7 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.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "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.

1.9 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

2.1 INSULATION MATERIALS


B. Insulation for below-ambient service requires a vapor-barrier.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. 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.

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

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

G. Calcium Silicate:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Industrial Insulation Group (IIG); Thermo-12 Gold.
   2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553,
   1. Type II and ASTM C 1290, Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

   2. Products: Subject to compliance with requirements, provide one of the following:
a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

J. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000-Degree Pipe Insulation.
   c. Manson Insulation Inc.; Alley-K.
   d. Owens Corning; Fiberglas Pipe Insulation.
   e. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A:
      1) with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied:

1. 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 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

L. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.2 INSULATING CEMENTS


1. Products: Subject to compliance with requirements, provide the following:
   a. Ramco Insulation, Inc.; Super-Stik.


1. Products: Subject to compliance with requirements, provide the following:
   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
2.3 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 290.
      d. Mon-Eco Industries, Inc.; 22-30.
      e. Vimasco Corporation; 760.

   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      d. K-Flex USA; R-373 Contact Adhesive.

   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.

   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

BYU MOTION PICTURE STUDIO  
CHILLER PLANT  

1. Products: Subject to compliance with requirements, provide one of the following:  
   b. Eagle Bridges - Marathon Industries; 225.  
   d. Mon-Eco Industries, Inc.; 22-25.  

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).  

F. PVC Jacket Adhesive: Compatible with PVC jacket.  

1. Products: Subject to compliance with requirements, provide one of the following:  
   a. Dow Corning Corporation; 739, Dow Silicone.  
   d. Speedline Corporation; Polyco VP Adhesive.  

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).  

2.4 MASTICS  

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.  

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).  

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.  

1. Products: Subject to compliance with requirements, provide one of the following:  
   b. Vimasco Corporation; 749.  

   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.  
   3. Service Temperature Range: Minus 20 to plus 180 deg F.  
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.  

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.  

1. Products: Subject to compliance with requirements, provide one of the following:
BYU MOTION PICTURE STUDIO
CHILLER PLANT

b. Eagle Bridges - Marathon Industries; 570.

2. Water-Vapor Permeance: ASTM F 1249, \textbf{0.05 perm} at \textbf{30-mil} dry film thickness.
3. Service Temperature Range: \textbf{Minus 50 to plus 220 deg F}.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, \textbf{1.8 perms} at \textbf{0.0625-inch} dry film thickness.
3. Service Temperature Range: \textbf{Minus 20 to plus 180 deg F}.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: \textbf{Minus 40 to plus 250 deg F}.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 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.

2.7 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. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: Color-code jackets based on system:
   a. 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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

   a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications:
      1) 1-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications:
      1) 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at
   a. 2 inches o.c.
   b. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. 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.
5. Handholes.
6. Cleanouts.
3.4 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 078413 "Penetration Firestopping" 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 078413 "Penetration Firestopping."

3.5 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, 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 locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

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 block insulation of same material and thickness as pipe insulation.

4. Finish flange insulation same as pipe insulation.

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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.

3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.7 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.

3.8 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.

3.9 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 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 Insulation shall have a k value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water, above 40 Deg F:

   1. NPS 1-1/2 inch and Smaller: Insulation shall be one of the following:
      a. Flexible Elastomeric:
         1) 1-1/2 inch thick.
      b. Mineral-Fiber, Preformed Pipe, Type I:
         1) 1-1/2 inches thick.

   2. NPS 2 inch and Larger: Insulation shall be one of the following:
      a. Flexible Elastomeric:
         1) 1-1/2 inch thick.
      b. Mineral-Fiber, Preformed Pipe, Type I:
         1) 1-1/2 inches thick.
3. Insulation runouts not exceeding 48 inches in length for connection to equipment shall be one of the following:

   a. Flexible Elastomeric: 1 inch thick.
   b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water:

   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 2 inches thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.15 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Section 232113.13 "Underground Hydronic Piping."

B. Chilled Water, All Sizes: Cellular glass 2 inches thick.

3.16 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, Concealed:

   1. None.

D. Piping, Exposed:

   1. PVC:
      a. White: 30 mils thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

   1. None.

D. Piping, Exposed:
1. Aluminum, Stucco Embossed: **0.016 inch** thick.

3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719
SECTION 230810 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. The contractor shall furnish and install a complete Variable Frequency Drive and Energy Efficient motor system on the following equipment as described in this specification and as indicated on the drawings.
   1. Pumps

B. The Variable Frequency Drive shall convert 208 volt, three phase, 60 Hz utility power to adjustable voltage and frequency, three phase, A-C power for stepless motor control from 6 to 60 Hz.

C. This contractor shall coordinate motor selection with Variable Frequency Drive.

D. Variable Frequency Drive Systems shall be compatible with any standard NEMA B or C design 3-phase induction motor. Variable Frequency Drive Systems shall be sized to insure the motor full load amps does not exceed the controller continuous RMS amps at project altitude (4500 ft.).

E. The VFD shall be interfaced to the building control system as specified in Section 230900.

1.3 QUALITY ASSURANCE

A. The equipment supplied under this specification shall conform to the latest applicable codes and standards of the following:
   2. ANSI/NEMA ICS 6 – Enclosures for Industrial Controls and Systems.
   3. NEMA AB1 – Molded Case Circuit Breakers.
   4. NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
   7. ANSI C57 – Distribution, Power, and Regulating Transformers (includes Reactors).
   8. UL 508C – Power Conversion Equipment.
10. FCC CFR 47 Part 15 subpart B.

B. The VFDs shall be UL listed for conformance to UL-508C. An equivalent safety labeling program by ETL or CSA documenting compliance with these industry standards will be acceptable.

C. The Division 23 Contractor shall coordinate and assume system responsibility and compatibility between the various approved suppliers’ equipment and services required to meet these specifications.

D. The VFD system vendor shall provide a complete parts and labor warranty (including travel and shipping expenses) for five (5) years from the date of substantial completion. The warranty shall cover the entire VFD system including power devices, controllers, harmonics, mitigation devices, communications interface, etc. furnished as part of the system package.

E. The mechanical contractor shall coordinate the mounting location of the VFD with the electrical contractor to be certain that it is not mounted in the airstream of unfiltered exhaust air; i.e. in a parking garage application.

1.4 SUBMITTALS

A. Shop Drawings: Submit shop drawings and product data in accordance with Section 230500 – Basic Mechanical Requirements.

1. VFD: Product data sheets, functional descriptions, performance ratings, dimensions, conduit entry/exit locations, installation instructions, complete wiring diagrams for power, controls, etc.
2. Control System Interface: Furnish complete documentation of the controls system interface including bus specification, object list, wiring diagrams, XIF or configuration files, etc.
3. Derate calculation for installation altitude above 3300 ft. and ambient temperature above 40°C.

B. Operating Instructions and Maintenance Data: Submit printed operating instructions and maintenance data in accordance with Section 230500 – Basic Mechanical Requirements.

1. VFD: Operating and Maintenance instructions, programming instructions, spare parts lists, troubleshooting instructions.
2. Factory test reports.
3. Start-up and commissioning reports.
4. Power quality and harmonic test reports.
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB.
   2. Mitsubishi

2.2 CONSTRUCTION, VARIABLE FREQUENCY DRIVE

A. The Variable Frequency Inverter(s) shall be PWM type using IGBTs, rated for the motor type, horsepower, and voltage as indicated on drawings.

B. The Inverter shall be altitude compensated and sized for the elevation at which the unit will be installed. The inverter shall operate in an ambient temperature of –10°C to 50°C humidity of 0-90% non-condensing. Inverter shall be mounted on a removable panel to facilitate maintenance. Inverter shall be VT rated.

C. The VFD system manufacturer shall integrate all components and equipment required to meet these specification features and functions as a single UL (or equivalent) labeled system. Vendors providing equipment requiring panel shop or job site modifications or additions that would not be valid under the original equipment manufacturers (OEM's) safety labeling will not be acceptable.

D. Pre-integrated equipment shall include but not be limited to incoming line filters, rectifier units, inverter units, control circuitry, operator interfaces, protective equipment, and other accessories and auxiliary items necessary to meet the highest standards for the type of service specified herein.

E. All VFD system components shall be housed in a grounded, dead front, free-standing or wall mounted, NEMA enclosure suitable for the conditions in which it is to be located. The VFD system size shall not exceed the size allotments specified on the drawings nor shall any portion of the system exceed a height of 90 inches. Entry shall be provided for incoming line and load cables as required or as shown on the drawings.

F. VFD systems mounted indoors shall be properly ventilated and sized to operate continuously at the job site elevation in an ambient environment of 0°C to 40°C, 0-90% RH. VFD systems mounted outdoors shall include environment control provisions as required (or as shown on the plans) to operate in an ambient of –30°C to 50°C, 0-100% RH.

G. All components of the VFD system shall be selected to operate continuously without any system trip or damage based on the nominal power specifications and requirements shown on the drawings or schedules. The above conditions must be maintained under the following expected variations:

   1. Plus or minus 10% voltage fluctuation.
   2. Plus or minus 3% frequency variation (5% if served by a back-up generator).
3. Distorted voltage waveform with up to 7% total voltage harmonic distortion.

H. The VFD system shall employ voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions:

1. 0% voltage for 1 cycle.
2. 60% voltage for 10 cycles.
3. 87% voltage continuous.

I. The VFD system shall employ door mounted industrial control operator devices, programming unit, and other devices as required to meet all functional and feature requirements of this specification. Operator pilot lights or LEDs, switches and pushbuttons (if required) shall be industrial oil tight industry standard devices.

J. Control voltages shall be 120 volts or less supplied by machine tool type transformers employing both primary and secondary fusing.

K. The VFD system factory wiring shall be permanently marked with hot emboss stamping or an equivalent marking system. All devices shall be labeled and identified with correct setting selections. All component identification and wiring shall be documented in the operation and maintenance manual.

L. The VFD system shall be capable of starting and continuously driving the specified maximum motor load as identified on the drawings and schedules.

M. VFD’s driving variable torque loads shall be programmed to optimize load patterns which maximize system efficiency and minimize motor heating and stresses. VFD’s driving constant torque or other loads shall be programmed to optimize load patterns for system or process performance as required.

N. All VFD systems shall have an overload capacity of a minimum of 120% for one minute.

O. Surge suppressors are required on the line side conductors feeding each VFD.

P. The VFD solid state converter and inverter power switching components and control shall be selected to achieve a 0.95 efficiency or better at full load and speed. Other auxiliary devices required on the drawings or in these specifications including filters, AC line reactors, cooling or heating devices etc. shall be of a design to optimize efficiency as intended under this specification.

Q. The entire true system power factor (as measured at the input to the VFD system) shall be 0.95 or better across the operational speed and load range. Power factor that becomes leading under light load conditions (due to PF correction) is acceptable only if voltage rise is prevented from backfeeding to the rest of the system (meaning PF correction must act like a synchronous condenser). The voltage tolerance at the main VFD system input terminals shall not be compromised as a result of power factor correction techniques.

R. Short circuit protection shall be provided to the VFD system through an externally operated, door interlocked fused disconnect, circuit breaker or motor circuit protector (MCP). VFD shall have a minimum short circuit rating of 65,00 amps RMS (100,000 amps RMS with DC bus
reactor) without additional input fusing. The door interlocked handle must be capable of being locked off to meet NEC.

S. Overcurrent protection shall be provided in the VFD system through electronic motor overload (MOL) circuits with instantaneous trip, inverse time trip, and current limit functions. These shall be adjustable and optimized for the application.

T. In addition to the overcurrent protection above, the VFD system shall provide over and under voltage protection, over temperature protection, ground fault protection, and control or microprocessor fault protection. These protective circuits shall cause an orderly shutdown of the VFD, provide indication of the fault condition, and require a manual reset (except undervoltage) before restart. Undervoltage from a power loss shall be set to automatically restart after return to normal. The history of the previous three faults shall remain in memory for future review.

U. The VFD system customer terminations shall be clearly identified with terminal numbers and a permanent wiring diagram located in the VFD system enclosure. Coordinate all control work with Section 230900 Contractor.

V. VFD shall meet the requirements for Radio Frequency Interference as specified by FCC Regulations, Part 15, Subpart J, Class A devices.

2.3 FEATURES, VARIABLE FREQUENCY DRIVES

A. The following operator control and indication features shall be provided standard (unless shown differently on the drawings) as part of each VFD system:

1. Hand-Off-Auto (local start at VFD, remote start with contact closure).
2. Local-Remote speed control (local speed control at VFD, remote speed control through speed reference signal).
3. Frequency (speed) indication.
5. Motor current indication.
6. VFD run indication.
7. VFD fault and diagnostic indication.

B. The following customer connections and interface terminations shall be provided standard (unless shown differently on the drawings) as part of each VFD system:

1. VFD remote start/stop connection.
2. External safeties connection.
3. VFD run annunciation.
4. VFD fault annunciation.
5. VFD speed reference input connection (4-20mA or as shown on drawings).
6. Minimum of three (3) programmable digital inputs.
7. Minimum of two (2) 4-20mA input signals to integral controller.
8. LonWorks BAS Interface Card

C. The following parameter adjustments shall be available to tune the VFD system:
1. Minimum and maximum speeds.
2. Acceleration and declaration times.
3. Overcurrent trip point.
5. Maximum base motor voltage.
6. Input speed reference signal gain and bias.
7. Output speed reference signal gain and bias.
8. Critical frequency avoidance.
9. Multiple preset speed programming.

D. The VFD shall be capable of starting into a rotating motor at any speed and rotation direction.

E. The VFD shall auto restart after a power failure.

F. For maintenance purposes, the VFD system shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).

G. The VFD shall be provided with a manual mechanical bypass contactor arrangement for transfer to the feeder line to operate the motor at constant speed.

   1. Bypass contactors shall be electrically and mechanically interlocked and provided with an adjustable motor overload relay. Provide an adjustable, mechanical overload unit for motor under 50 HP. For motors 50 HP and larger, provide an adjustable, electronic overload unit.
   2. The VFD bypass arrangement shall include a VFD isolation contactor or other method to allow the VFD to be serviced or removed while in bypass operation.
   3. In addition to other specified operator devices, a "VFD/Bypass" selector switch and "Bypass On" pilot light shall be supplied as part of the VFD system.
   4. "Electronic Bypass", or systems that rely on an electronic circuit board or keypad for bypass operation are unacceptable under this specification.

H. VFD shall include an integral locking disconnect.

2.4 FACTORY TEST, VARIABLE FREQUENCY DRIVE

A. Prior to shipping any equipment, the manufacturer shall individually test and certify each unit to document compliance. This certification report shall be submitted as part of the operation and maintenance manual and include the following minimum testing:

   1. A visual inspection shall be made consisting of all system components, wiring connections, and safety mechanisms.
   2. High pot testing shall be conducted on the completed VFD system including all accessory power components as a complete package. This test shall be conducted per UL 508C (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.
   3. A system run test shall be conducted using an actual motor accelerated and decelerated through the entire speed range.
   4. All control panel devices, including switches, pilot lamps, keypad and special control devices shall be functional tested.
2.5 POWER QUALITY

A. Power Factor - Each VFD system shall provide a minimum of 95% displacement power factor at the VFD system terminals.

B. IEEE 519-1992 Compliance - Compliance with IEEE STD. 519-1992 (Recommended Practices for Harmonic Control in Electrical Power Systems) shall be a requirement of this project. Harmonic filters (passive or active), phase multiplication devices, or any other components required to mitigate harmonic voltage and current, shall comply with IEEE STD. 519-1992 published levels, as identified in items #1 and #2, listed below, and shall be an integral part of the VFD system. Designs which are not pre-integrated and factory wired as part of the UL (or equal) labeled VFD system shall not be acceptable under this specification.

1. 10 HP VFD and larger shall be provided with integrated harmonic mitigation filters or phase multiplication inputs and transformers to be <12% ITHD at the VFD system terminal input at full load.
2. 7.5 HP VFD and smaller shall be supplied with a 3% reactor.
3. Passive Filter Design
   a. Passive filter designs which utilize capacitive circuits shall include integrated fusing of the capacitors.
   b. Passive filter designs which utilize capacitive circuits shall include an integrated capacitor cut-out contactor circuit that is programmable to de-energize capacitors based on a user selection of load or speed, with hysteresis to prevent contactor chattering.
4. Active Filter Design
   a. Active filter designs shall include EMI/RFI filtering and any other required circuits to prevent high frequency noise interference with other building systems.
   b. Phase multiplication designs shall be totally self-contained in the VFD system and include any phase shifting transformers, balancing reactors, or other equipment to perform as specified regardless of electrical system imbalance.

C. Relevant data for VFD system vendor calculations to meet IEEE Std. 519-1992 requirements are as follows:

1. For the purpose of this specification, the Point of Common Coupling (PCC) as identified in IEEE Std. 519-1992, shall be the connection at which each individual VFD system (the offending non-linear load) is connected to the electrical distribution system (linear loads). Required voltage and current harmonic distortion measurements shall be taken at each individual VFD system PCC.
2. The load current (IL) is used to calculate the IEEE Std. 519-1992 ISC/IL ratio required for determining acceptable maximum harmonic current distortion values as shown above. For the purposes of this specification, this calculated current (IL) shall be the total combined full load current of each VFD system supplied as part of this project.
3. The VFD system vendor is responsible to determine the short circuit current (ISC) available at the PCC through the drawings, through coordination with other equipment suppliers, from the electric utility, and/or from actual job site electrical equipment nameplate or measurement data.

D. Documentation of IEEE Std. 519-1992 compliance shall be part of the commissioning required by the VFD supplier. Actual job site measurement testing shall be conducted at one half and full load and documented in the operation and maintenance manuals. Reports shall include the following data:

1. Data (text and graphical) shall be supplied showing voltage and current waveforms, THD (or TDD) and individual harmonic spectrum analysis in compliance with the above standards.
2. Power quality reports including transformer derate analysis, telephone influence factor, true and displacement power factor, and voltage and current imbalance reports shall also be supplied.
3. It is the responsibility of the VFD supplier to measure, document and report to the owner the THD at the utility metering point. The VFD supplier needs to coordinate with the electrical contractor before and when the measurements are made.

E. Stand-by generator compatibility - the generator supplier shall verify compatibility between the VFD system and the stand-by generator serving any VFD systems being installed.

F. The following companies have been pre-approved to meet the harmonic testing and documentation section of this specification.

1. Energy Management Corporation
2. Midgely Huber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field start-up service shall be provided by an authorized factory representative. The supplier shall provide warranty and authorized factory services including field start-up and training. The following adjustments and tests shall be performed as a minimum with certified copies included in the operation and maintenance manual:

1. Verify that the input voltage is within the manufacturer's specification tolerances.
2. Verify that the motor rotation is correct in all modes of operation.
3. Verify all operator devices, programming, and monitoring functions to be fully operational.
4. Verify operation of all field signal control connections.
5. Measure and record system output voltage and current at 50% and 100% speed.
6. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.
7. Make all parameter adjustments to tune and optimize the VFD system to the application. Record all configuration values as part of this report.

8. Conduct harmonic tests as identified in this specification. Measurements shall be recorded for each unit with the VFD system off, running at 50% speed, and running at full speed and load.

B. Owner training shall be provided for each model and type of VFD system provided.

C. Training shall consist of both classroom and actual equipment hands-on training.

D. Installation shall be in accordance with manufacturer's printed instructions.

E. The mechanical contractor shall coordinate the mounting location of the VFD with the electrical contractor to be certain that it is not mounted in the airstream of unfiltered exhaust air; i.e. in a parking garage application. If no location is feasible to meet this location criteria, the VFD may be mounted inside a NEMA 3R enclosure in the dirty air location.

F. Permanently engraved 3” x 5” lamicoid labels are required to identify the equipment controlled, electrical source feeding the controller, voltage, number of phases, disconnect or fuse size in amps, and equipment horsepower. Additionally, a second label on the VFD cabinet is required, specifying which control signal is used. For normal power, labels are to have a black background with white engraved letters. For emergency power, labels are to have a red background with white letters. Each label shall be affixed to the cabinet in a readily visible location with double sided adhesive tape covering the back of the nameplate.

3.2 SPARE PARTS

A. Furnish one spare main logic board, key pad, and power supply board. Furnish one set of spare parts for each unique VFD design supplied.

END OF SECTION
SECTION 230900
BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY
   A. Control equipment for HVAC systems and components.

1.2 QUALITY ASSURANCE
   A. Quality Standard: Comply with ASHRAE 135 for DDC system components.

1.3 CONTROL SYSTEM
   A. System to control mechanical systems per the mechanical equipment schedule and drawings.
   B. **Delta Control System** hardware, design drawings, software and start-up shall be furnished to BYU by Atkinson Electronics Inc. under a separate owner direct purchase order.
   C. The system shall be installed by SAC, BCS, Lone Peak, D&L Electric, or Colt under this contract. **Refer to mechanical bid breakdown form for approved installers.**

1.4 RELATED WORK SPECIFIED ELSEWHERE:
   A. Drawings and general provisions of the Contract, including General and supplementary Conditions and Division-1 specification sections, apply to work of this section.
   B. Section 230913 “Instruments and Control Elements”
   C. Section 230993 “Sequences of Operations”
   D. Products furnished but not installed under this section:
      1. Valves, flow switches, flow sensors, thermowells and pressure taps to be installed under Division 23.
   E. Automatic dampers to be furnished under Division 23.
   F. Coordination with electrical:
      1. Installation of all line voltage power wiring by Division 26.
      2. Each motor starter provided under Division 26, shall be furnished with individual control power transformer to supply 120 volt control power and auxiliary contacts (one N.O. and one N.C.) for use by this section.
      3. Control system shall be on emergency power provided by Division 26.
1.5 SUBMITTALS

A. Submit 10 complete sets of documentation in the following phased delivery schedule:
   1. Valve and damper schedules
   2. Equipment data cut sheets
   3. System schematics, including:
      a. Point to point wiring / communications
      b. Interface wiring diagrams
      c. Panel layouts
      d. System riser diagrams
      e. Sequence of Operations
   4. Software:
      a. Graphics (including samples of project specific graphics)
      b. Point names
      c. Point addresses
      d. Point to point wiring check-off lists

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:
   1. Index sheet, listing contents in alphabetical order
   2. Manufacturer’s equipment parts list of all functional components of the system, disk of system schematics, including wiring diagrams
   3. Description of sequence of operations
   4. As-Built interconnection wiring diagrams
   5. User’s documentation containing produce, system architectural and programming information.
   6. Trunk cable schematic showing remote electronic panel locations, and all trunk data
   7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
   8. Conduit routing diagrams
   9. Copy of the warranty/guarantee
   10. Operating and maintenance cautions and instructions
   11. Recommended spare parts list

1.6 BALANCING COORDINATION

A. Contractors shall include time as necessary to assist the balancing contractor in balancing of the project.

1.7 The Facility Management Control System (BAS) shall be comprised of a network of interoperable, stand-alone digital controllers. The BAS shall incorporate BacNet technology. The system shall include:

A. Programmable Equipment Controllers (PEC’s) for control of primary mechanical systems and distributed system applications. Controllers shall be fully programmable to create custom control solutions.

B. Network Area Controllers (NAC’s) for distributed system applications, databases and networking functions.

C. Application Specific Controllers (ASC’s) for control of VAV terminal units, Fan coil terminal units, Unit heaters, and other terminal equipment.
D. Graphical User Interface (GUI), which includes the hardware and software necessary for a user to interface with the control system and devices.

1.8 NETWORK AREA CONTROLLER (NAC)

A. The Network Area Controller (NAC) shall provide the interface between the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization
   6. Integration of BACnet controller data
   7. Integration of BACnet and MODBUS networks
   8. Network Management functions for all BACnet based devices
   9. Employ Niagara AX operating system

B. The NAC shall provide multiple, concurrent user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

C. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

D. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   1. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
   2. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
      a. To alarm
      b. Return to normal
      c. To fault
   3. Provide for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
   4. Provide timed (schedule) routing of alarms by class, object, group, or node.
   5. Provide alarm generation from binary object “runtime” and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

E. Alarms shall be annunciated in any of the following manners as user defined:
   1. Screen message text
   2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
      a. Day of week
      b. Time of day
      c. Recipient
   3. Pagers via paging services that initiate a page on receipt of email message
   4. Graphic with flashing alarm object(s)
   5. Printed message, routed directly to a dedicated alarm printer

F. The following shall be recorded by the NAC for each alarm (at a minimum):
   1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (air handler #, access way, etc.)
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

G. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

H. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

I. Provide a “query” feature to allow review of specific alarms by user defined parameters.

J. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

K. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

L. Data Collection and Storage
1. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
2. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
   a. Designating the log as interval or deviation.
   b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
   c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
   d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
   e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
3. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
4. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
5. All log data shall be available to the user in the following data formats:
   a. HTML
   b. XML
   c. Plain Text
   d. Comma or tab separated values
6. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
7. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
   a. Archive on time of day
   b. Archive on user-defined number of data stores in the buffer (size)
   c. Archive when buffer has reached its user-defined capacity

M. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the
NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
1. Time and date
2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

N. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
1. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
2. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE EQUIPMENT CONTROLLERS (PEC)

A. Programmable Equipment Controllers (PEC’s) shall be stand-alone, multi-tasking, real-time digital control processors.

B. The PEC’s shall communicate via native BacNet MSTP protocol. Provide a minimum of 4MB Random Access Memory in each PEC.

C. The PEC must communicate peer-to-peer with the all of the network application specific, programmable controllers and third party BacNet devices.

D. Programming of the PEC shall be accomplished by using graphical software that incorporates drag and drop capabilities. The PEC software database must be able to execute all of the specified mechanical system controls functions. The programming software shall be able to bundle software logic to simplify control sequencing. All values, which make up the PID output value, shall be readable and modifiable at a workstation or portable service tool. Each input, output, or calculation result shall be capable of being shared/bound with any controller or interface device on the network.

E. PEC’s shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

F. A single process shall be able to incorporate measured or calculated data from any and all other PEC’s on the network. In addition, a single process shall be able to issue commands to points in any and all other PEC’s on the network.

G. Each PEC shall support firmware upgrades without the need to replace hardware.

H. Each PEC shall continuously perform self-diagnostics, which include communication diagnosis and diagnosis of all components. The PEC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

I. In the event of the loss of normal power, there shall be an orderly shutdown of all PEC’s to prevent the loss of database or operating system software. Non-volatile memory shall be
incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the PEC shall automatically resume full operation without manual intervention.
2. All PEC’s control programming and databases must be stored in Flash memory, therefore eliminating data loss, down time and re-load time.

2.2 APPLICATION SPECIFIC CONTROLLERS (ASC)

A. Each Application Specific Controller (ASC) shall operate as a stand-alone BacNet compliant controller capable of performing its specified control responsibilities independent of other controllers in the network. Each ASC shall be a minimum 16-BIT microprocessor based, multi-tasking, multi-user, real time digital control processor.

B. Controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog and digital outputs shall be industry standard signals such as 0-10V and 3-point floating control allowing for interface to a variety of industry standard modulating actuators. The ASC inputs and outputs shall consist of industry standards types. Inputs shall be electrically isolated from outputs, communications and power. All inputs shall be provided with an auto-calibrate function to eliminate sensing errors.

C. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the network is not acceptable.

D. The ASC must be mounted remotely from the room sensor. ASC’s, that are wall mounted with integral room sensors, are not acceptable.

E. The control program shall reside in the ASC. The application program and the configuration information shall be stored in non-volatile memory with no battery back-up required.

F. After a power failure the ASC must run the control application using the current set points and configuration. Reverting to default or factory setpoints are not acceptable.

2.3 PROJECT SPECIFIC WEB PAGES:

A. Home page shall include a campus layout of the individual buildings at the site. Once an individual building is selected the following minimum web-based tree structure shall be provided:
   1. Documents Page: The document page shall include the O&M Manuals for the control system in PDF format along with AutoCAD drawings for each drawing provided in the control system O&M Manual.
   2. Station Functions:
      a. Logging separate sheet of station functions for a particular selected building shall be the viewing of one or more logs or the creation of logs in which any value at any point, or the mode of any point, shall be selected via the web to be trended against any other point with an adjustable frequency in seconds, minutes, hours or days.
      b. The alarm acknowledgement via the web shall allow the viewing and acknowledgement of the alarms.
      c. Audit log shall be provided via the web to show the operator actions as well as other audit logs as specified in section 2.5 Network Area Controller (NAC) paragraph “M” Data Collection and Storage.
   3. Systems:
a. On selecting the systems menu, a tree structure shall allow the operator to select the air handlers, control valves, pumps, etc. systems associated with that building. The graphics shall also show the piping and ductwork associated with the air handler as well as the safeties, temperature sensors, humidity sensors, dampers, VFD’s, associated with that fan system. See points list for specifics.

b. All devices that provide dynamic function in the primary equipment, i.e., fans, pumps, coils, dampers shall be dynamic in nature showing their operating status/percentage of capacity by movement on the web page.

c. The set points for the various control loops shall be adjustable via the web page. Individual controlled devices, i.e., valves, dampers, and fans shall be controlled via the web page and be stopped or started or placed in a command state or percentage of value output.

2.4 FIELD DEVICES

A. Provide automatic control valves, automatic control dampers, thermostats, time clocks, sensors, controllers, and other components as required for the complete installation of the system, except as otherwise indicated, provided published product information, designed and constructed as recommended by the manufacturer.

1. See section 230913 – Instruments and Control Elements

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT

A. Provide a project manager who shall, as part of his duties, be responsible for the following activities;
   1. Coordination between the Controls Contractor and all other trades, owner, local authorities and the design team.
   2. Scheduling of manpower, materials delivery, equipment installation and checkout.
   3. Maintenance of construction records such as project scheduling and manpower planning and AutoCAD or Visio of project coordination and as-built drawings.
   4. Coordination/Single point of contact

3.2 INSTALLATION METHODS FOR CONTROL SYSTEM

A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications.

B. The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices.

C. To run BACnet on the Ethernet network, the installer is required to run, at minimum, plenum rated CAT 5e cabling for all runs associated with this network.

D. All exposed wiring, low and line voltage subject to mechanical damage, shall be run in conduit. Line and low voltage wiring shall be run in separate conduits. Concealed but accessible wiring, except in mechanical rooms and areas where other conduit and piping are exposed shall be run in UL plenum rated cable as approved by local codes unless expressly restricted by requirements in Division 26 specification minimum conduit size is 3/4 EMT.
1. Provide wiring in raceways inside insulated wall cavities.
2. Clearly identify all control wiring and provide “Brady” tagging using the “As-Built” I.D. for each cable. Identify control system wiring junction boxes with “medium blue” color covers.
3. Mount thermostats or room temperature sensors on outlet boxes
4. Splices in data communication wiring and temperature sensing cables are not allowed.

E. All Controllers, Relays, Transducers, etc., required for stand-alone control shall be housed in a NEMA 1 enclosure with a lockable door.

F. All control panels shall be sized for the power required by the controls in the cabinet

3.3 SYSTEM ACCEPTANCE

A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request. When the field test procedures have been demonstrated to the Owner's representative, the system will be accepted. The warranty period will start at this time.

B. Field Equipment Test Procedures: DDC control panels shall be demonstrated via a functional end-to-end test. Such that:
1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.
2. All analog input channels shall be verified for proper operation.
3. All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.

C. As-Built Documentation: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. As built drawings shall include all control device locations and identifications including thermostats, controllers, panels and sensors. After receiving final approval, supply "6" complete 11x17 as-built drawing sets, together with AutoCAD diskettes to the owner.

D. Operation and Maintenance Manuals: Submit four copies of operation and maintenance manuals. Include the following:
1. Manufacturer's catalog data and specifications on sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.
2. A copy of the warranty.
3. Operating and maintenance cautions and instructions.

3.4 TRAINING

A. Contractor shall provide to the engineer a training class outline prior to any scheduled training.
B. Factory trained control engineers and technicians shall provide training sessions for the Owner’s personnel.

C. The control contractor shall conduct six (6) four-hour training courses for the designated owner’s personnel in the maintenance and operation of the control system. One class shall be given before system acceptance and the others monthly into the warranty/guarantee time period.

D. The course shall include instruction on specific systems and instructions for operating the installed system to include as a minimum:
   1. HVAC system overview
   2. Operation of Control System
   3. Function of each Component
   4. System Operating Procedures
   5. Programming Procedures
   6. Maintenance Procedures

E. WARRANTY
   1. The control system shall be warranted to be free from defects in both material and workmanship for a period of one (1) year of normal use and service. This warranty shall become effective the date the owner accepts or receives beneficial use of the system as defined by Utah state law. Warranties shall begin at substantial completion.

PART 4 - SEQUENCES OF OPERATION (SEE SECTION 230993)

END OF SECTION
SECTION 230913
INSTRUMENTS AND CONTROL ELEMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Control panels.
B. Control Valves:
   1. Globe pattern.
   2. Electronic operators.
C. Dampers. See Section 233300
D. Damper Operators:
   1. Electric operators.
E. Humidistats:
   1. Room humidistats.
   2. Limit duct humidistats.
F. Input/Output Sensors:
   1. Temperature sensors.
   2. Humidity sensors.
   3. Static pressure (air pressure) sensors.
   4. Equipment operation (current) sensors.
   5. Damper position indicators.
   7. Carbon dioxide sensors.
G. Thermostats:
   1. Electric room thermostats.
   3. Room thermostat accessories.
H. Time clocks.
I. Transmitters:
   1. Building static pressure transmitters.
   2. Pressure transmitters.
   3. Air pressure transmitters.
   5. Temperature transmitters.
J. Energy Metering: Refer to section
K. Flow Sensors:
   1. Airflow measurement array (AFMA).
   2. Ultrasonic flow meters.
   3. Flow switches.

1.02 RELATED REQUIREMENTS
A. Section 230519 - Meters and Gages for HVAC Piping: Thermometer sockets, gage taps.
B. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
C. Section 230923 - Direct-Digital Control System for HVAC.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  ______________________________
INSTRUMENTS AND CONTROL ELEMENTS

D. Section 230993 - Sequence of Operations for HVAC Controls.
E. Section 232113 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps.
F. Section 232114 - Hydronic Specialties.
G. Section 233300 - Air Duct Accessories: Installation of automatic dampers.
H. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.
I. Section 262725 - Wiring Devices: Elevation of exposed components.

1.03 REFERENCE STANDARDS
D. ANSI C12.20 - American National Standard for Electricity Meters - 0.2 and 0.5 Accuracy Classes; 2015.
E. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
I. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.
L. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
M. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 2013-08, with 2015 Corrigendum.
N. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
O. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats; 2013.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Bidding conditions - Paul
B. Project coordination - Paul
C. Third party procurement - NIC Jim Sawka
D. Start-up / programming / commissioning Jim Sawka
E. Preinstallation Meeting: Conduct a preinstallation meeting at least one week before starting work of this section; require attendance by all affected installers.
F. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

I __________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.Print Date: 2020-01-02

Signature & Date: ______________________________________  _______________________________
1.05 SUBMITTALS
   A. See Section 013000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
   C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
   D. Manufacturer's Instructions: Provide for all manufactured components.
   E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
   F. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
      1. Revise shop drawings to reflect actual installation and operating sequences.
   G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
   H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 016000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE
   A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in Utah.
   B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
   C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years experience.
   D. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.

1.07 WARRANTY
   A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective work within a five year period after Substantial Completion.
   C. Provide five year manufacturer's warranty for control air compressors.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL
   A. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.
2.02 CONTROL PANELS
   A. Unitized cabinet type for each system under automatic control with relays and controls mounted in
      cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on
      cabinet panel face.
   B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
   C. Provide common keying for all panels.

2.04 CONTROL VALVES
   A. Globe Pattern:
      1. Manufacturers:
         a. Belimo
         b. Siemens
         c. Substitutions: See Section 016000 - Product Requirements.
      2. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed
         ends with backseating capacity repackable under pressure.
      3. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat
         and disc.
      4. Hydronic Systems:
         a. Rate for service pressure of 125 psig at 250 degrees F.
   B. Butterfly Pattern:
      1. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends,
         extended neck.
      2. Hydronic Systems:
         a. Rate for service pressure of 125 psig at 250 degrees F.
         b. Size for 1 psig maximum pressure drop at design flow rate.
   C. Pressure Independent Pattern:
      1. Manufacturers:
         a. Belimo, PIQCV or PICCV.
         b. Grizwald, Pinnacle or PIC-V.
         c. Substitutions: See Section 016000 - Product Requirements.
      2. Pressure Independent Control Valves shall maintain the required flow rate regardless of
         pressure changes.
      3. Brass body, stainless steel trim, EPDM, teflon packing material
      4. Valves shall spring return to normal position as indicated on freeze, fire, or temperature
         protection.
      5. Select operator for full shut off at maximum pump differential pressure.
      6. In locations that utilize pressure independent valves balance valve is not required.
   D. Electronic Operators:
      1. Manufacturers:
         a. Belimo
         b. Substitutions: See Section 016000 - Product Requirements.
      2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature
         protection.
      3. Select operator for full shut off at maximum pump differential pressure.
2.05 DAMPERS - SEE SECTION 233300

2.06 DAMPER OPERATORS
   A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
      1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
      2. Provide one operator for maximum 36 sq ft damper section.
   B. Electric Operators:
      1. Manufacturers:
         a. Siemens
         b. Belimo
      2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.07 HUMIDISTATS

2.08 INPUT/OUTPUT SENSORS
   A. Temperature Sensors:
      1. Temperature sensors shall be linear precision elements with ranges appropriate for each specific application.
   B. Humidity Sensors:
      1. Humidity sensors shall be of the solid-state type using a capacitance-sensing element. The sensor shall vary the output voltage with a change in relative humidity. Room humidity sensors shall have a minimum range of 10% to 90% ±5%. Supply air humidity sensors shall have a normal range of 10% to 90% ±5%.
   C. Static Pressure (Air Pressure) Sensors:
      1. The pressure sensor shall be temperature compensated and shall vary the output voltage with a change in differential pressure. Sensing range shall be suitable for the application with linearity of 1.5% of full scale and offset of less than 1% of full scale. Sensor shall be capable of withstanding up to 150% of rated pressure without damage. Sensor range shall not exceed 4 times the setpoint.
   D. Equipment Operation (Current) Sensors:
      1. Motor status indications, where shown on the plans point list shall be provided via current sensing relays. The switch output contact shall be rated for 30 VDC, .15 amps with adjustable setpoint.
   E. Carbon Dioxide Sensors, Duct and Wall:
      1. The CO2 sensor shall be a non-dispersive infrared sensor. The diffusion gas chamber in the sensor shall incorporate a gold plated, reflective light pipe or waveguide surrounded by a permeable teflon based hydrophobic diffusion filter that prevents particulate and water contamination of the sensor. For long-term stability, the sensor shall utilize a dual channel infrared detector, one channel for CO2 absorption, the other for reference to correct for long term sensor drift. The sensor shall provide simultaneous analog outputs in volts and milliamps. All sensor electronics shall be conformal coated for durability. The sensor shall incorporate elevation correction adjustment and
have an accuracy of plus or minus 50 ppm or 5% (7% for levels over 1500 ppm) at temperatures of 60-90 Degrees F (15-32 Degrees C). All Adjustments to the sensor including output scaling, elevation, adjustment, relay dead-band, proportional or exponential output, and single-point calibration shall be made via computer connected to an on-board RJ45 jack. For ease of installation, the sensor shall have a detachable base with all field wiring terminals on base.

2.09 THERMOSTATS
A. Room Thermostat Accessories:
   1. Space (room) sensors serving single zone spaces (offices, conference rooms, small performance areas) shall be available with setpoint adjustment and override switch.
   2. Space (room) sensors with shown on the plans as averaging type, or those in public areas and large performance spaces shall be non-adjustable type.
B. Outdoor Reset Thermostats:
   1. Sunshields shall be provided for outside air sensors.
C. Immersion Thermostats:
   1. Thermowells for all immersion sensors shall be stainless steel or brass as required for the application.
D. Airstream Thermostats:
   1. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufacture recommendation and looped and fastened at a minimum of every 36 inches.
E. Electric Low Limit Duct Thermostats:
   1. Shall be the manual reset type. The thermostat shall operate in response to the coldest one-foot length of the 20-foot sensing element, regardless of the temperatures at other parts of the element. The element shall be properly supported to cover the entire downstream side of the coil with a minimum of three loops. Separate thermostats shall be provided for each 24 square feet of coil face area or fraction thereof. Freeze stat shall be set for 37°F.

2.10 TIME CLOCKS

2.11 TRANSMITTERS
A. Building Static Pressure Transmitters:
B. Pressure Transmitters:
C. Air Pressure Transmitters:
   1. Pressure differential switches shall have SPDT changeover contact, switching at an adjustable differential pressure setpoint.
D. Water Pressure Transmitters (Liquid Differential Pressure Transmitters):
E. Temperature Transmitters:
F. Humidity Transmitters:
2.12 TRANSDUCERS

2.13 ENERGY METERING
   A. Hydronic BTU (J) Meters: See section 230519

2.14 FLOW SENSORS
   A. Flow Nozzles:
   B. Venturi Tubes:
   C. Airflow Measurement Array (AFMA):
      1. Provide Ebtron-gold airflow measurement stations (AFMA) as indicated on plans.
      2. AFMA shall consist of single or multiple probes as required to achieve an airflow measurement accuracy of ± 3% of reading.
      3. AFMA probe assemblies must have multiple sensors that use instrument grade thermal dispersion, temperature compensated, thermistor sensing technology and digital electronics
      4. The AFMA manufacturer and/or their local representative shall recommend and approve the actual location for the AFMA and determine whether or not a honeycomb straightener is required.
      5. Vortex shedding or pitot tube arrays and differential pressure sensing arrays with sensors that require auto-zeroing will not be accepted.
      6. Ebtron is the basis of design and is powered by the low voltage controls. If another manufacturer is used and separate line voltage power is required, it will be the responsibility of this section to coordinate and provide at no additional cost to the owner.

   F. Ultrasonic Flow Meters: See Section 230519
   G. Insertion Turbine Flow Meters:
   H. Insertion Magnetic Flow Meters:
   I. Paddle Type Flow Meters:
   J. Vortex Shedding Flow Meters:
   K. Positive Displacement Flow Meters:
   L. Gas Flow Meters:
   M. Flow Switches:
      1. Flow Switches: Motor status indications, where shown on the plans point list, shall be provided via flow switches. Flow switches shall be of the paddle type equipped with SPDT contacts to establish proof of flow.

2.15 LEVEL INSTRUMENTS
   A. Submersible Level Transmitters (Liquids Other Than Potable Water):
      1. Provide for aluminum tanks, chemical storage tanks, oil tanks, wastewater, sludge pits, clarifiers, digesters, lime slurry, sumps, reservoirs, and _____.
      2. Function: Measurement of the height of liquid above the position in the tank referenced to atmospheric pressure.
4. Large diameter 316 stainless steel diaphragm seal, non-clogging and damage resistant to floating solids.
5. Equip with a minimum 270 lb tensile strength, shielded and vented cable.

B. Flush Tip Submersible Level Transmitters:
C. Submersible Level Transmitters (Potable Water):
D. Miniature Submersible Level Transmitters:
E. Compact Visual Level Indicators:
F. Customizable Visual Level Indicators:
G. Ultrasonic Liquid Level Transmitter:
   1. Manufacturers:
      a. Flowline; Echotouch:
   2. Characteristics: Non-contact liquid level sensor intrinsically safe for use in hazardous locations and provides continuous level measurement up to 18 feet. LCD display, NEMA 4X enclosure, simple push button calibration for all user set points, adjustable dead band and range filters.
   3. Range: 6 inches to 18 feet.
   4. Accuracy: plus/minus 0.25% of range
   5. Resolution: 0.125"
   6. Dead band: 6"
   7. Beam width: 8" conical
   8. Configuration: Push button
   9. Memory: Non-volatile
   10. Display type: LCD, 4-digit
   11. Display units: inches or cm
   12. Supply voltage: 12 - 32 VDC
   13. Signal output: 4-20 mA, two wire
   14. Signal fail-safe: Reverts to safe state during echo loss
   15. Process temp.: -4 degrees to 140 degrees F
   16. Pressure: 30 psi @ 25 degrees C
   17. Approvals: CSA: Class I, Groups A, B, C, D; Class II, Groups E, F, G; Class III; T3C

2.16 LEVEL SWITCHES
A. Manufacturers:
B. Capacitive Sensors:
   1. Capacitive Level Switch:
   2. Through Wall Capacitive Sensor:
   3. Flush Capacitance Level Switch:
C. Conductivity Sensors:
   1. Conductivity Controller:
   2. Conductivity Level Probe:
D. Diaphragm Sensors:
E. Displacer Sensors:
   1. Two Stage Top Mount Displacer Type Level Control:
F. Float Sensors:
   1. Float Switch:
   2. Liquid Level Switch:
   3. Mini-Size Level Switch:
   4. Multi-Level Switch Kit:
5. Liquid Level Switch (Leak Resistant):
6. Insertion Type Level Control:
7. Welded Chamber Level Control:
8. Top Mount Float Type Level Control:
9. Free-Floating Level Switch:
10. Flanged Chamber Level Control:
11. Cable Float Switch:
12. Flanged Chamber (Adjustable Deadband):
13. Flanged Chamber (External Mount):
14. Welded Construction:

G. Optical Sensors:
H. Paddle Sensors:
I. Tilt Sensors:
J. Tuning Fork Sensors:
K. Rod Sensors:

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that systems are ready to receive work.
C. Beginning of installation means installer accepts existing conditions.
D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
F. Ensure installation of components is complementary to installation of similar components.
G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. Check and verify location of thermostats and exposed control sensors with plans and room details before installation. Locate 48 inches above floor. Align with lighting switches and humidistats. Refer to Section 262725.
C. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MAINTENANCE
A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
B. Provide service and maintenance of control system for one year from Date of Substantial Completion.
C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

I __________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers. Print Date: 2020-01-02

Signature & Date: ______________________________________  _______________________________
D. In addition to normal service calls, make minimum of ____ complete normal inspections of approximately ____ hours duration to inspect, calibrate, and adjust controls.

END OF SECTION
Section 230993 – SEQUENCES OF OPERATION

PART 1 SEQUENCES OF OPERATION

1.0 SECTION INCLUDES

1. General Information
2. Unit Heater and Exhaust Fan
3. Chilled Water System
4. Glycol Feed System

1.1 General Information

A. Power Failure - Except for the equipment noted below, all supply, return, relief, exhaust, pumps, etc. shall stop on power failure. When power has been restored to normal for a minimum of two minutes, the mechanical equipment shall restart at 30-second intervals (adjustable) in a predetermined sequence.

B. Schedule - Although specific set points, time periods and reset values are listed in the sequence of operation, all values shall be changeable through the Facility Management System console or portable operators’ terminal. The initial occupied/unoccupied schedules shall be as designated by the owner’s representative.

C. Point Database - Inputs and outputs required to meet the sequence of operation shall be provided, whether they are listed in the Input/Output schedule or not. All points listed in the Input/Output schedule shall also be provided.

1.2 Unit Heater and Exhaust Fan

A. A BACnet thermostat shall monitor the space temperature. When the space temperature falls below the heating set point the controller shall enable the electric unit heater. When the temperature return above the heating set-point the controller shall disable the electric unit heater.

B. A BACnet thermostat shall monitor the space temperature. When the space temperature rises above the cooling set point the controller shall enable the exhaust fan. When the temperature returns below the cooling set point the controller shall disable the exhaust fan.

C. The controller shall not allow the exhaust fan and the unit heater to operate at the same time.

1.3 Chilled Water System

A. Secondary Chilled Water Pumps

1. The lead secondary pump shall be enabled whenever the outside air temperature is above 60 degrees F and one of the AHU's is calling for chilled water.

2. The lead pump shall operate continuously. If the lead pump fails, then the lag pump shall be enabled. An alarm shall be sent to the building operator that the lead pump has failed via the BAS system. The pump in the lead position shall be rotated every month (adjustable by the building operator).
3. A differential pressure sensor shall be located, as determined by owner/engineer, and shall monitor the pressure between the supply and return chilled water pressures. A DDC controller shall compare the reading using a PID loop to the system differential pressure set point (10 PSI adjustable). The controller shall then modulate the speed of the lead pump via a speed control signal to the pump VFD. If the lead pump cannot meet the differential pressure set point, the lag pump shall be enabled and the pumps shall operate in parallel.

B. Normal Chiller Staging Operation

1. On a call for cooling CH-1(existing) chiller and its associated pump shall be enabled as the first chiller stage. The BAS shall monitor the chiller loading via the BACnet interface to the chiller. When the chiller is loaded to 90% then CH-2 (new) chiller shall be enabled as the second chiller stage. The two chillers shall then operate in parallel. Then the two chillers are loaded to 90% then CH-3 shall be enabled as the third stage and the three chillers shall operate in parallel.

2. The chillers shall be disabled as the load at each stage reaches 40% in the reverse order that they were enabled such that CH-1 is the last chiller to be disabled.

3. The positions of CH-2 and CH-3 shall be rotated every month (adjustable).

1.4 Glycol Feed System

A. The glycol feed system shall come with all control devices and controllers as necessary to provide a complete and operable system. The ATC contractor shall provide all interlock wiring necessary. The BMS shall monitor a call for glycol makeup as well as a low-level alarm on the glycol fill tank.

Part 2: Points List

2.1 POINTS LIST

These are the minimum points that shall be available through the Building Automation system (BAS). Any other points that are required in order to perform the sequences of operation shall also be available via the BAS.

<table>
<thead>
<tr>
<th>Glycol Feed System</th>
<th>AV</th>
<th>Al</th>
<th>Bi</th>
<th>Ao</th>
<th>Bo</th>
<th>Trend</th>
<th>Graph</th>
<th>Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Level Alarm on Fill Tank</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Call for Glycol Makeup</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex fan – Elec Unit Heater</th>
<th>AV</th>
<th>Al</th>
<th>Bi</th>
<th>Ao</th>
<th>Bo</th>
<th>Trend</th>
<th>Graph</th>
<th>Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Temperature</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex Fan Start/Stop</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex Fan Status</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Unit Heater Start/Stop</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Unit Heater Status</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Space Heating Temperature Setpoint</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>AV</td>
<td>AI</td>
<td>BI</td>
<td>AO</td>
<td>BO</td>
<td>Trend</td>
<td>Graph</td>
<td>Alarm</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Space Cooling Temperature Setpoint</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Chilled Water System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Air Temperature</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Chilled Water Supply Temperature</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Chilled Water Return Temperature</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CHW Sec Pmp 1 Start/Stop</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CHW Sec Pmp 1 Status</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHW Sec Pmp 1 Speed</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CHW Sec Pmp 2 Start/Stop</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CHW Sec Pmp 2 Status</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CHW Sec Pmp 2 Speed</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CHW Sec Differential Pressure</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CHW Sec System DP Setpoint</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Chiller Point Available via BACnet Ports</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Hydronic system requirements.
F. Chilled water piping, buried.
G. Chilled water piping, above grade.
K. Equipment drains and overflows.
L. Pipe hangers and supports.
M. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 RELATED REQUIREMENTS
A. Section 078400 - Firestopping.
B. Section 083100 - Access Doors and Panels.
C. Section 099123 - Interior Painting.
D. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.
E. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
F. Section 220553 - Identification for Plumbing Piping and Equipment.
G. Section 220719 - Plumbing Piping Insulation.
H. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
I. Section 230523 - General-Duty Valves for HVAC Piping.
J. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
K. Section 230553 - Identification for HVAC Piping and Equipment.
L. Section 230719 - HVAC Piping Insulation.
M. Section 232114 - Hydronic Specialties.
N. Section 232500 - HVAC Water Treatment: Pipe cleaning.
O. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.
C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
E. ASME B31.9 - Building Services Piping; 2014.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of all underground piping, service entrances to buildings with size, location and installation of service utilities with BYU Physical Facilities Construction Manager.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
B. Preinstallation Meeting: Conduct a preinstallation meeting 4 days prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

D. Scheduling: All scheduling shall be coordinated and agreed upon with BYU Physical Facilities Project Coordinator prior to commencing work.

1.05 SUBMITTALS
A. See Section 013000 - Administrative Requirements, for submittal procedures.
B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
C. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturers catalogue information.
   3. Indicate valve data and ratings.
   4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
E. Project Record Documents: Record actual locations and typical position of valves.
F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Valve Repacking Kits: One for each type and size of valve.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum five years of documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.
C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
D. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
   1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
E. Deliveries shall not be to owner, but directly to the contractor.

1.08 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS
2.01 HYDRONIC SYSTEM REQUIREMENTS
A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Grooved mechanical joints may be used in any location except direct buried.
   a. Grooved mechanical connections and joints comply with AWWA C606.
      1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
      2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
   b. Use rigid joints unless otherwise indicated.
   c. Use flexible joints only at structural expansion joints as indicated by architect or engineer.
   d. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
   e. Provide steel coupling nuts and bolts complying with ASTM A183.
4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
   1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

D. Valves: Provide valves where indicated:
   1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; coordinate, with owner, piping to nearest floor drain.
   2. On discharge of condenser water pumps before isolation and check valve, use spring loaded check valves.
   3. Isolate equipment using butterfly valves (4" and above) with lug end flanges or grooved mechanical couplings.
   4. For manual throttling, manual bypass, or manual flow control services, use ball or butterfly valves.
   5. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.

E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.04 CHILLED WATER PIPING, BURIED

D. HDPE Pipe

2.05 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
   2. Threaded Joints: ASME B16.3, malleable iron fittings, 3" and below only.

B. Steel Pipe Sizes 12 Inch and Greater: ASTM A53/A53M, 3/8 inch wall, black; using one of the following joint types:
   2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), hard drawn; using one of the following joint types:
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8BCuP copper/silver alloy.
      a. Manufacturers:
         1) Grinnell Products; ______ 
         2) Viega LLC; ______ 
         3) Substitutions: See Section 016000 - Product Requirements.

D. RTRP Pipe: ASTM D2310, fiberglass reinforced thermosetting resin plastic.
   1. Fittings: Fiberglass reinforced epoxy.

E. Stainless Steel Pipe: ASTM A53/A53M, Schedule 40, 304 or 316.
   2. Joints: Threaded for pipe 2 inch and under; AWS D1.1/D1.1M, welded for pipe over 2 inch.

2.09 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
   1. Fittings: ASTM D2466 or D2467, PVC.
   2. Joints: Solvent welded in accordance with ASTM D2855.

C. PVC Pipe Sizes 8 Inch and Greater: ASTM D1785, Schedule 80, or ASTM D2241, SDR 21 or 26.
   1. Fittings: ASTM D2466 or D2467, PVC.
   2. Joints: Solvent welded in accordance with ASTM D2855.

D. ABS Pipe: ASTM D2680.
   1. Fittings: Compatible with piping material.

2.10 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
   5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
   6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
16. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

C. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
5. Height: Provide minimum clearance of 18 inches under pipe to top of roofing.
6. Manufacturers:
   a. Miro;
   b. BLine;
   c. Substitutions: See Section 016000 - Product Requirements.

2.11 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 4 inches and Less:
1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered or Propress joints.

B. Flanges for Pipe 2 Inches and Greater:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
2. Mechanical Couplings: Comply with ASTM F1476.
3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
7. Manufacturers:
   a. Grinnell Products;
   b. Victaulic Company;
   c. Anvil International; Gruvlock.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
d. Substitutions: See Section 016000 - Product Requirements.

D. Dielectric Connections:
   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short
circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600 volt breakdown test.
      c. Construct of stainless steel with threaded end connections to match connecting piping.
      d. Suitable for the required operating pressures and temperatures.
   2. Flanges:
      a. Dielectric flanges with same pressure ratings as standard flanges.
      b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short
circuit current in a corresponding bimetallic joint.
      c. Dry insulation barrier able to withstand 600 volt breakdown test.
      d. Construct of galvanized steel with threaded end connections to match connecting piping.
      e. Suitable for the required operating pressures and temperatures.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
C. Remove scale and dirt on inside and outside before assembly.
D. Prepare piping connections to equipment using jointing system specified.
E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
F. After completion, fill, clean, and treat systems. Refer to Section 232500 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME
   B31.9 requirements.
C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
D. Route piping in orderly manner, parallel to building structure, and maintain gradient.
E. Install piping to conserve building space and to avoid interfere with use of space.
F. Group piping whenever practical at common elevations.
G. Pipe passing through partitions, walls and floors shall be sealed with Link-Seal.
H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials
   and methods specified __________.
I. Slope piping and arrange to drain at low points.
J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected
   equipment. Refer to Section 230516.
   1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal
      contraction in lieu of expansion loops.
   2. Use flexible couplings in expansion loops where approved by engineer or indicated on drawings.
K. Grooved Joints:
   1. Install in accordance with the manufacturer's latest published installation instructions.
   2. Gaskets to be suitable for the intended service, molded, and produced by the coupling
      manufacturer.

L. Inserts:

I ______________________________________ the Principal in Charge on this project have reviewed this section and it is in
accordance with the Instructions to Architects & Engineers.

Signature & Date: ___________________________________________________________
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
4. Where inserts are omitted and approved by engineer, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut on top of slab.

M. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
3. Place hangers within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Provide copper plated hangers and supports for copper piping.
8. Prime coat exposed steel hangers and supports. Refer to Section 099123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

N. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 230719.

O. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083100.

P. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting where indicated on drawings.

Q. Install valves with stems upright or horizontal, not inverted.

R. Chilled Water Piping: Clean exterior surfaces. Brush or roll three coats RustOleum "RustOCrylic" 5700, Red Primer (5769), grey coat (5781), finish (5779) to 4-6 mil final film thickness. Sherwin Williams equivalent allowed.

END OF SECTION
SECTION 232114  
HYDRONIC SPECIALTIES  

PART 1 GENERAL  

1.01 SECTION INCLUDES  
   B. Expansion tanks.  
   C. Air vents.  
   D. Air separators.  
   E. Strainers.  
   F. Suction diffusers.  
   G. Pump connectors.  
   H. Pressure-temperature test plugs.  
   I. Balancing valves.  
   J. Relief valves.  
   K. Pressure reducing valves.  
   L. Glycol system.  

1.02 RELATED REQUIREMENTS  
   A. Section 221006 - Plumbing Piping Specialties: Backflow preventers.  
   B. Section 232113 - Hydronic Piping.  
   C. Section 232500 - HVAC Water Treatment: Pipe cleaning.  

1.03 REFERENCE STANDARDS  

1.04 ADMINISTRATIVE REQUIREMENTS  
   A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.  
   B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.  

1.05 SUBMITTALS  
   A. See Section 013000 - Administrative Requirements, for submittal procedures.  
   B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.  
   C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.  
   D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.  
   E. Project Record Documents: Record actual locations of flow controls.  
   F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.  
   G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.  

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.  

Signature & Date: ______________________________________  _______________________________  

BYU STANDARD  
SPECIFICATION 2018 REV 1.0
1. See Section 016000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.02 EXPANSION TANKS
A. Manufacturers:
   1. Amtrol Inc; ______
   2. ITT Bell & Gossett; ______
   3. Taco, Inc; ______
   4. American Wheatley HVAC Products;
   5. Armstrong;
B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 150 psi, with replaceable flexible EPDM or butyl rubber diaphragm, and steel support stand.
C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi.
D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
E. Size and capacity as per drawings.

2.03 AIR VENTS
A. Manufacturers:
   1. Armstrong International, Inc; ______
   2. ITT Bell & Gossett; ______
   3. Taco, Inc; ______
   4. Hoffman Specialty ITT;
   5. SpiraxSarco;
B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
C. Float Type:
   1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
   2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.
D. Washer Type:
   1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________
2.04 AIR SEPARATORS

A. In-line Air Separators:
1. Manufacturers:
   a. Armstrong International, Inc; ______
   b. ITT Bell & Gossett; ______
   c. Taco, Inc; ______
   d. Amtrol;
   e. Substitutions: See Section 016000 - Product Requirements.
2. Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for [] operating pressure.

B. Coalescing Air/Dirt Separators:
1. Manufacturers:
   a. Spirotherm, Inc; ______
   b. Substitutions: See Section 016000 - Product Requirements.
2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for [] operating pressure and 225 degree maximum operating temperature; subject to the requirements of the application and the manufacturer's standard maximum operating conditions.
3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
4. Air Vent: Integral float actuated air vent at top fitting of tank rated at [], threaded to the top of the separator.
5. Inlet and Outlet Connections: Threaded for [] and smaller; Class 250 flanged connections for 2-1/2 NPS and larger.
7. Size: Match system flow capacity.

2.05 STRainers

A. Manufacturers:
1. Armstrong International, Inc; ______
2. Flexicraft Industries; ______
3. Grinnell Products, a Tyco Business; ______
4. The Metraflex Company;
5. Watts;
6. Victaulic;
7. SpirexSarco;
8. Substitutions: See Section 016000 - Product Requirements.

B. Size 2 inch and Under:
1. Screwed brass or iron body for a minimum of 200 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen, full size drain connection with ball valve.

C. Size 2-1/2 inch to 4 inch:
1. Provide flanged or grooved iron body for [] working pressure, Y pattern with 1/16 inch, 3/64 inch, or ____ inch stainless steel perforated screen, drain connection with ball valve.

D. Size 5 inch and Larger:
1. Provide flanged or grooved iron body for [] working pressure, basket pattern with 1/8 inch stainless steel perforated screen, drain connection with ball valve.

2.06 SUCTION DIFFUSERS

A. Manufacturers:
1. Anvil International, Inc; ______
2. Grinnell Products, a Tyco Business; ______
3. ITT Bell & Gossett;
4. Victaulic Company of America;
5. Substitutions: See Section 016000 - Product Requirements.

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.07 PUMP CONNECTORS

A. Manufacturers:
1. The Metraflex Company; Vane Flex:
2. Flex Hose Co.;
3. Flexicraft Inc.;

B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
1. Maximum Allowable Working Pressure: 175 psig at 120 degrees F.
2. Accommodate the Following:
   b. Lateral Movement: _____ inch.
   c. Angular Rotation: 15 degrees.
   d. Force developed by 1.5 times specified maximum allowable operating pressure.
3. End Connections: Same as specified for pipe jointing.
4. Provide pump connector with integral vanes to reduce turbulent flow.

2.08 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:
1. Ferguson Enterprises Inc; ______
2. Peterson Equipment Company Inc; ______
3. Sisco Manufacturing Company Inc; ______

B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

C. Application: Use extended length plugs to clear insulated piping.

2.09 BALANCING VALVES

A. Manufacturers:
1. ITT Bell & Gossett; ______
2. Taco, Inc; ______
3. IMI Flow Design;

B. Size 2 inch and Smaller:
1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
2. Metal construction materials consist of bronze or brass.
3. Non-metal construction materials consist of Teflon or EPDM.

C. Size 2.5 inch and Larger:
1. Provide ball or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, or EPDM.

2.10 RELIEF VALVES
A. Manufacturers:
   1. Watts;
   2. Armstrong International, Inc; ______
   3. ITT Bell & Gossett; ______
   4. Conbraco Industries; ______
   5. Substitutions: See Section 016000 - Product Requirements.
B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.11 PRESSURE REDUCING VALVES
A. Manufacturers:
   1. Watts;
   2. Armstrong International, Inc; ______
   3. ITT Bell & Gossett; ______
   4. Taco, Inc; ______
   5. Substitutions: See Section 016000 - Product Requirements.
B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 232113.
C. Materials of Construction:
   1. Valve Body: Constructed of bronze, cast iron, brass, iron, or ________.
   2. Internal Components: Construct of stainless steel, brass, or ________ and engineered plastics, composition material, or ________
D. Connections:
   1. NPT threaded: 0.50 inch, 0.75 inch, or ____ inch.
   2. Soldered: 0.50 inch, or ____ inch.
E. Provide integral check valve and strainer.
F. Maximum Inlet Pressure: 100 psi.
G. Maximum Fluid Temperature: 180 degrees F.
H. Operating Pressure Range: Between 10 psi and 25 psi.

2.13 GLYCOL SYSTEM
A. Manufacturers:
   1. Power Engineering Company;
   2. Aurora;
   3. Pacific;
   4. Neptune;
B. Polyethylene feed tank mounted on a steel frame with accommodations for mounting a pump underneath. Tank shall have a hinged lid and all interconnecting piping to pump including strainer.
C. Level switch to deactivate pump and activate alarm on low level.
D. Control panel to house switching device for pump, audible alarm, HOA switch for pump, lights to indicate power and low level, pushbutton for alarm silence. Enclosure shall be NEMA 12. Control panel shall be mounted on the tank stand.
E. Rotary gear pump of bronze construction. Capacity shall be as scheduled on the drawings.

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________

BYU STANDARD 2018 REV 1.0

HYDRONIC SPECIALTIES
F. 1/2” bronze, solenoid valve mounted in the feed line from the pump to the system. The valve shall be activated the same time as the pump.

G. Pressure switch set at such a psig (adjustable) to activate the pump and solenoid valve. Pump shall be deactivated at adjustable psig. Pressure sensing shall be made in the main chilled water line on the discharge side of the pump.

H. 1/2” bronze, relief valve mounted on the system side of the solenoid valve and piped back to the tank.

I. Glycol Solution:
   1. Preheat Systems:
      a. 40% glycol by volume for the snow melt system. Inhibited propylene glycol as manufactured by Dow Chemical Dowfrost HD.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Where large air quantities can accumulate, provide enlarged air collection standpipes.

C. Provide manual air vents at system high points and as indicated.

D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

E. Provide air separator on suction side of system circulation pump and connect to expansion tank.

F. Provide valved drain connection or hose connection, where applicable, on strainer blow down.

G. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

H. Support pump fittings with floor mounted pipe and flange supports.

I. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

J. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

K. Pipe relief valve outlet to nearest floor drain.

L. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

M. Clean and flush glycol system before adding glycol solution. Refer to Section 232500.

N. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

O. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

P. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

Q. Perform tests determining strength of glycol and water solution and submit written test results.

3.02 MAINTENANCE

A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.

B. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION

I _________________________ the Principal in Charge on this project have reviewed this section and it is in accordance with the Instructions to Architects & Engineers.

Signature & Date: ______________________________________  _______________________________

BYU STANDARD
SPECIFICATION 2018 REV 1.0
SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS
   A. Buna-N: Nitrile rubber.
   B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of pump. Include certified performance curves and rated capacities, shipping weights, installed weights, 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.
         a. Detail all wiring systems and differentiate clearly between manufacturer-installed and field-installed wiring.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
1.6 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Regulatory Requirements: Fabricate and test steam condensate pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.8 COORDINATION

A. Coordinate size and location of concrete bases.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Flofab
5. ITT Corporation; Bell & Gossett.
6. Mepco, LLC.
7. PACO Pumps; Grundfos CBG.
9. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded or threaded companion-flange or union-end connections or unions at connections for casings that are not available with threaded companion flanges.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft: Steel, with oil lubricated copper-alloy shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings:
   1. Oil lubricated, bronze-journal.

D. Motor: Single speed and rigidly or resiliently mounted to pump casing.

   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   a. Enclosure: Open, dripproof.
   b. Enclosure Materials:
      1) Cast iron.
   c. Motor Bearings:
      1) Grease-lubricated ball bearings.
   d. Efficiency:
      1) Premium efficient.
   e. Service Factor: 1.15

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

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. ITT Corporation; Bell & Gossett.
4. PACO Pumps; Grundfos CBG.
5. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
6. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, bronze fitted, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, bronze fitted, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange or flanged connections.
   a. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps without frequency-drive control, trim impeller to match specified performance.

3. Pump Shaft: Steel, with copper-alloy shaft sleeve.

4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration.

1. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Enclosure: Open, dripproof.
   b. Enclosure Materials: Cast iron.
c. **Motor Bearings:** Grease-lubricated ball bearings.

d. Efficiency: Premium efficient.

e. Service Factor: 1.15

2.3 **PUMP SPECIALTY FITTINGS**

A. Suction Diffuser:

1. Angle pattern.
2. **175-psig** pressure rating, **cast-iron** body and end cap, pump-inlet fitting.
3. Bronze startup and **bronze** or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. **Factory-fabricated** support.

**PART 3 - EXECUTION**

3.1 **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.

3.2 **PUMP INSTALLATION**

A. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Comply with **HI 1.4**.

C. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

F. Equipment Mounting:
1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03 “Cast-in-Place Concrete.”
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

G. **Equipment Mounting:** Install in-line pumps with continuous-thread hanger rods and spring hangers elastomeric hangers of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

### 3.3 Alignment

A. **Engage a factory-authorized service representative to perform** alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.4 Connections

A. Comply with requirements for piping specified in Division 23 Section "Steam and Condensate Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. **Install check, shutoff, and throttling** on discharge side of pumps.

E. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

F. Install **suction diffuser** and shutoff valve on suction side of vertical-inline and base-mounted pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Install thermometers at pump suction and discharge.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to 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 that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
      b. Verify bearing lubrication.
      c. 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.
      d. 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. Open cooling water-supply valves in cooling water supply to bearings, where applicable.
   7. Open cooling water-supply valves if stuffing boxes are water cooled.
   8. Open sealing liquid-supply valves if pumps are so fitted.
   9. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
   10. Open circulating line valves if pumps should not be operated against dead shutoff.
   12. Open discharge valve slowly.
   13. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
   14. Check general mechanical operation of pumps and motors.
15. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

B. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 1 Section Contract Closeout.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 232123
SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes the following water treatment for closed-loop hydronic systems:
      2. Automatic chemical-feed equipment.
      3. Chemicals.

1.3 DEFINITIONS
   A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
   B. RO: Reverse osmosis.
   C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS
   A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
      1. Bypass feeders.
      2. Water meters.
      3. Chemical solution tanks.
      4. Chemical material safety data sheets.
   B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
      1. Include plans, elevations, sections, and attachment details.
      2. Include diagrams for power, signal, and control wiring.
1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Other Informational Submittals:
   1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
   1. Initial water analysis and HVAC water-treatment recommendations.
   2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
   4. Laboratory technical analysis.
   5. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Power Engineering Co.

2.2 PERFORMANCE REQUIREMENTS

A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including:
   1. Chilled water

D. Closed hydronic systems, shall have the following water qualities:
   1. pH: Maintain a value within the combined recommendations of the various equipment manufacturers.
   2. Nitrite: Maintain a value within 800 to 1000 ppm.
   3. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of zero organisms/mL.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass 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. 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.

   1. Capacity:
      a. 5 gal.

   2. Minimum Working Pressure:
      a. 125 psig

2.4 CHEMICALS

A. 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.
2.5 GLYCOL FEED SYSTEM

A. One (1) 50-gallon polyethylene feed tank. Wall thickness shall be a minimum of ¼”. Tank shall be mounted on a steel frame with accommodations for mounting a pump underneath. Tank shall be supplied with a removable lid and all interconnecting piping to pump including strainer and isolation valve. Tank height including stand shall not exceed 48”. Tank stand shall be finished with an epoxy powder coating to protect against corrosion.

B. One (1) Level switch to deactivate pump and activate alarm on low glycol level in the feed tank.

C. One (1) Control panel shall house switching device for pump, audible alarm, HOA switch for pump, lights to indicate power and low level, pushbutton for alarm silence. Enclosure shall be NEMA 12. Control panel shall be mounted on the tank stand.

D. One (1) 1/3 HP centrifugal pump mounted under the feed tank. Materials of construction shall be bronze. Pump shall provide 2.5 GPM at 60 PSIG. Rotary gear pump is not acceptable.

E. Pressure switch shall be Honeywell L404F1078 or Square D 9012 GNG-4. One (1) Pressure switch set at:
   1. Field determine PSIG to activate the glycol feed pump.
   2. Field determine PSI for differential setting for the pressure switch.

F. GLYCOL
   1. The glycol provided shall be propylene glycol as manufactured by Dow Chemical or Huntsman Chemical. Trade name shall be DowFrost HD or JeffCool HD. The water quality in the hot/chilled water system shall meet the recommendations of the glycol manufacturer so as to reduce the formation of sludge. If the water quality at the jobsite does not meet manufacturers recommendations then the glycol solution shall be provided pre-mixed with deionized water. An analysis of the glycol solution and the water quality shall be included in the O&M manuals. Glycol percentage shall be:
      a.  50% by volume.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
C. Install water testing equipment on wall near water chemical application equipment.

D. Install glycol feed system per manufacturers recommendations.

E. Install interconnecting control wiring for chemical treatment controls and sensors.

F. Mount sensors and injectors in piping circuits.

G. Bypass Feeders: Install in closed hydronic systems, including:
   1. Hot-water heating
   2. Chilled water

H. Bypass Feeders: Install in closed hydronic systems, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   2. Install water meter in makeup-water supply.
   3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
   5. Install a swing check on the inlet after the isolation valve.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."

C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
3.4 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. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. At quarterly intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.

F. Comply with ASTM D 3370 and with the following standards:


3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

3.6 CLEANING AND FLUSH OF HYDRONIC SYSTEMS

A. Cleaning and Flushing of Heating Piping and Cooling Piping: Filters shall be placed in the circulating hot water or chilled water systems during the construction period to remove foreign matter. After the completion of the heating and cooling water systems installation and all pressure tests, the contractor shall clean out pipes under the supervision of Power Engineering Co. The systems shall be filled with Ziolite softened water (Deionized Water) and checked for leakage and debris. Add the proper amount of PECO 5483 liquid cleaner, or PECO equivalent, and circulate at a velocity of not less than .5 ft/sec. for 24 hours at 120°F - 150°F, or 48 hours at less than 120°F. Drain and flush piping; clean strainers. Flush with fresh deionized water until system PH is no more than 8.0. The Central Heating Plant and Chiller Plant pumps, and building heating and cooling equipment cannot be used during the washing-out period; therefore, it will be the responsibility of Power Engineering Co. to furnish auxiliary equipment for this purpose. Provide report of procedure and results. Company approved to do work is Power Engineering Co.

END OF SECTION 232513
SECTION 233001 - COMMON DUCT REQUIREMENTS

PART 1 - PRODUCTS

1.1 SUMMARY

A. Includes But Not Limited To:
   1. General procedures and requirements for ductwork.
   2. Repair leaks in ductwork, as identified by smoke test, at no additional cost to Owner.
   3. Soundproofing procedures for duct penetrations of walls, ceilings, and floors in mechanical equipment rooms.

B. Related Sections:
   1. Division 07: Quality of Acoustic Sealant.
   2. Section 23 0500: Common Work Results for HVAC
   3. Section 23 0593: Testing Adjusting and Balancing for HVAC.

1.2 SUBMITTALS

A. Samples: Sealer and gauze proposed for sealing ductwork.

B. Quality Assurance / Control:
   1. Manufacturer’s installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
   2. Specification data on sealer and gauze proposed for sealing ductwork.

1.3 QUALITY ASSURANCE

A. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.

B. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

PART 2 - PRODUCTS

2.1 Finishes, Where Applicable: Colors as selected by Architect.

2.2 Duct Hangers:
   A. One inch by 18 ga galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches apart. Do not use wire hangers.
1. Attaching screws at trusses shall be 2 inch No. 10 round head wood screws. Nails not allowed.

2. Attach threaded rod to steel joist with Grinnell Steel washer plate Fig. 60 - ph-1. Double nut connection.

2.3 Penetration Soundproofing Materials:

A. Insulation for Packing: Fiberglass.
B. Calking: Polysulphide.
C. Escutcheon Frame: 22 ga galvanized iron 2 inches wide.

PART 3 - EXECUTION

3.1 INSTALLATION

A. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.

B. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.

C. Hangers And Supports:

1. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
2. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
3. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
4. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
5. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

D. Penetration Soundproofing

1. Pack space between ducts and structure full of fiberglass insulation of sufficient thickness to be wedged tight, allowing space for application of calking.
2. Provide calking at least 2 inches thick between duct and structure on both ends of opening through structure.
3. Provide metal escutcheon on Equipment Room side. Secure escutcheon to wall.
3.2 CLEANING

A. Clean interior of duct systems before final completion.

END OF SECTION 233001
SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

B. Related Sections:
   1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
   3. Section 230713 “Duct Insulation” for duct insulation and fire wrap.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: 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. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
13. Duct fabrication shall not begin until shop drawings have been submitted and reviewed by the mechanical engineer.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including, but not limited to the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

B. Field quality-control reports.
1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 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. Duct dimensions shown on drawings are inside clear dimensions.

E. 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."

2.2 SINGLE-WALL ROUND 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. Duct dimensions shown on drawings are inside clear dimensions.
C. 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."

   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Not allowed.

E. 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."

2.3 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.

   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. 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.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
2. Maximum Thermal Conductivity:
   a. Type I, Flexible: \(0.27 \text{ Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.}\)
   b. Type II, Rigid: \(0.23 \text{ Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.}\)

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Water-Based Liner Adhesive:
   a. Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   b. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA Inc.
   b. Armacell LLC.
   c. Rubatex International, LLC

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
   a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. 0.135-inch-diameter shank.

2. Insulation-Retaining Washers: With beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Self-locking washers formed from 0.016-inch-thick aluminum.

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
8. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. 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.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
   10. 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).
C. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   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.

D. Solvent-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Base: Synthetic rubber resin.
   4. Solids Content: Minimum 60 percent.
   5. Shore A Hardness: Minimum 60.
   7. Mold and mildew resistant.
   8. 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).
   9. VOC: Maximum 395 g/L.
   10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
   11. Service: Indoor or outdoor.
   12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   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).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.
2.6 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:
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 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 on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round 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.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

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 2 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 233300 "Air Duct Accessories" for fire and smoke dampers.


3.2 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.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class A.
4. Unconditioned Space, Exhaust Ducts: Seal Class A.
5. Conditioned Space, Exhaust Ducts: Seal Class A.

3.4 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.

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 intervals 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.

3.5 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."


3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:


2. Test the following systems:
   a. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Any liner showing evidence that is has wet at any time shall be removed and replaced with new liner.
   a. Disinfect affected sheet metal, and pins.
   b. Install new liner per specifications
   c. Seal friable edges and seams of repaired liner.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system before testing, adjusting, and balancing.
B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   6. Provide drainage and cleanup for wash-down procedures.
   7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.
3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel.

B. Ductwork running in areas where there are no ceilings or when noted on the drawings shall be doubled wall duct and shall meet the requirements indicated below.

C. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
      a. Pressure Class: Negative 2-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 16.
      d. SMACNA Leakage Class for Round: 4.
   2. Ducts Connected to Equipment Not Listed Above:
      a. Pressure Class: Positive or negative 4-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 4.
      d. SMACNA Leakage Class for Round: 2.

D. Intermediate Reinforcement:
   2. PVC-Coated Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.

3. Aluminum Ducts: Aluminum.

E. Duct Liner Restrictions:
   1. Duct Liner exposed to air movement shall not be used on medium pressure ductwork (2000 to 4000 FPM velocity). See section 230713 “Duct Insulation” for insulation requirements.
2. Duct Liner exposed to air movement shall not be used on high pressure ductwork (Greater than 4000 FPM velocity). See section 230713 “Duct Insulation” for insulation requirements.

3. All duct liner shall meet all of the requirements found in 2012 IECC

F. Liner: (Ductwork located in Unconditioned space)

1. Exhaust Air Ducts: Fibrous glass, Type I or flexible elastomeric [Natural fiber], 1 inch thick.

G. Liner: (Ductwork located Interior to building Insulated Envelope)

1. Exhaust Air Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick.

H. Double-Wall Duct Interstitial Insulation:

1. Exhaust Air Ducts: 1-1/2 inch thick with a minimum R value of 6.0.

I. Exterior Ductwork Liner Insulation:

1. Exhaust Air Ducts: 2 inch thick with a minimum R value of 8.0.

J. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. 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: 1.0 radius-to-diameter ratio and three segments for 90-degree elbow.
   2) Velocity 1000 to 1500 fpm: 1.5 radius-to-diameter ratio and four segments for 90-degree elbow.
   3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

K. 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 high efficiency take-off.
   b. Rectangular Main to Round Branch: 45-degree entry high efficiency take-off.

2. Round:
   a. 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.
   b. Velocity 1000 to 1500 fpm: 45-degree entry high efficiency tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113
SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
1. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS
A. Project Altitude: Base fan-performance ratings on:
1. Actual Project site elevations.
B. Operating Limits: Classify according to AMCA 99.
C. Fan Schedule: Fan characteristics and performance data are described in an equipment schedule on the drawings including:
1. Fan arrangement with wheel configuration, inlet and discharge configurations, and required accessories.
2. Capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, shipping weights, operating weights, operating characteristics, and furnished specialties and accessories. Also include the following:
1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
   a. Detail all wiring systems and differentiate clearly between manufacturer-installed and field-installed wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control Reports

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 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. Belts: One set for each belt-driven unit.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Power ventilator electrical components shall comply with applicable NEMA standards.

D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

E. TUV Certified: High Volume low speed fan shall comply with UL 507
BYU MOTION PICTURE STUDIO
CHILLER PLANT

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PRODUCTS FURNISHED BUT NOT INSTALLED

A. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans. Roof curbs to be installed by Division 07, section "Roof Accessories".

2.2 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Loren Cook Company.
   3. Twin City.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing with:
   1. Wheel, inlet cone.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
   1. Fan Guard: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet on units not connected to ductwork, where contact with fan wheel is within personal reach through access opening, or where falling objects and/or debris may enter fan.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Dampers:
      a. Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
b. Motorized parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. These dampers to be black in all cases.

3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
4. Disconnect Switch: Nonfusible type:
   a. Thermal-overload protection; factory wired through an internal aluminum conduit.
      1) Mounted inside fan housing.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed;
   1. Fan cooled

2.4 FACTORY FINISH

A. Metal Parts: All assembly parts shall be protected from rust and corrosion.
   1. Stainless steel, aluminum, and other non-corroding materials require no protective finish.
   2. Non-galvanized sheet metal parts shall be prime coated or powder coated before final assembly.
   3. Prime coated parts shall receive baked enamel finish coat after assembly.

2.5 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the power ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.
3.2 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements. Verify clearances.

B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

3.3 INSTALLATION

A. Install power ventilators level and plumb according to manufacturer's written instructions.

B. Base Mounted Equipment:
   1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in:
      a. Division 33 "Cast-in-Place Concrete."

C. Support Steel: Support suspended units from structure using threaded steel as specified in Division 23 "Vibration and Seismic Controls for HVAC."

D. Label units according to requirements specified in Division 23 "Identification for HVAC Piping and Equipment."

E. Install power ventilators with factory recommended and code required clearances for service and maintenance.

3.4 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."
   1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."
   1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Comply with requirements in Division 23 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
D. Replace fan and motor pulleys as required to achieve design airflow.
E. Lubricate bearings.

3.7 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.
D. Demonstrate operation of power ventilators. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

END OF SECTION 233423
SECTION 236423 - SCROLL WATER CHILLERS

GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.3 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. BAS: Building automation system.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Centrifugal chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

C. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make factory modifications to standard chiller design and adjustments to affected chiller components to account for site altitude, if necessary.
D. Performance Tolerance: Comply with AHRI 550/590.

1.5 ACTION SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Performance at AHRI standard conditions and at conditions indicated.
   2. Performance at AHRI standard unloading conditions.
   3. Minimum evaporator flow rate.
   4. Refrigerant capacity of water chiller.
   5. Oil capacity of water chiller.
   6. Fluid capacity of evaporator and condenser.
   7. Characteristics of safety relief valves.
   9. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 10 deg F increments.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Structural supports.
   2. Piping roughing-in requirements.
   3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
   4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on:
      a. Test of assembled components by a nationally recognized testing standard procedure, such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demand determined by Section 13.3 of ASCE 7.
      b. An engineering analysis conforming to the requirements of Chapter 13 of ASCE 7.
      c. Experience data conforming to a nationally recognized procedure. The
BYU MOTION PICTURE STUDIO
CHILLER PLANT

substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.
E. Startup service reports.
F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE
A. AHRI Certification: Certify chiller according to AHRI 550/590 certification program.
B. AHRI Rating: Rate chiller performance according to requirements in AHRI 550/590.
C. AHRI Rating: Chiller sound data measured in accordance with AHRI 370 for units mounted outdoors.
D. ASHRAE Compliance:
   1. ASHRAE 15 for safety code for mechanical refrigeration.
   2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
F. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.
G. Comply with NFPA 70, National Electric Code (NEC).
H. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance. Units delivered to site without such label shall be field certified by ETL or UL with label registered and field applied. Provide field certification report prepare by the listing agency. All cost for field certification shall be paid by the manufacturer.
1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate anchor bolt sizes, concrete base thickness and anchor bolt edge setback requirements as required by Section 230248 “Vibration Isolation and Seismic Restraint.”

1.11 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.3 PACKAGED AIR-COOLED WATER CHILLERS

A. MANUFACTURERS – Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a United Technologies company;
2. Daikin Applied (McQuay);
3. Trane, a division of Ingersoll-Rand;
4. York, a Johnson Control Company.

2.4 MANUFACTURED UNIT

A. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

B. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.

C. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 1000-hour salt-spray test according to ASTM B 117.
5. Sound Reduction Package:
   a. Acoustic enclosure around compressors.
   b. Reduced-speed fans with acoustic treatment.
   c. Designed to reduce sound level without affecting performance.

E. Compressors:
1. Description: Positive-displacement direct drive scroll compressor with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.

F. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

G. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

H. Refrigeration:
1. Refrigerant: R-410a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory installed positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
5. Pressure Relief Device:
   a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME
Boiler and Pressure Vessel Code: Section VIII, Division 1.

b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

I. Evaporator: Brazed-plate, as scheduled on Plans.

2. Brazed Plate:
   a. Direct-expansion, single-pass, brazed-plate design.
   b. Type 316 stainless-steel construction.
   c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
   d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.

I. Air-Cooled Condenser:

1. Plate-fin coil with integral sub-cooling on each circuit, rated at 450 psig.
   a. Construct coils of copper tubes mechanically bonded to aluminum fins.
   c. Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

3. Fan Motors: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

4. Fan Guards: Steel safety guards with corrosion-resistant coating.

K. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key.

3. Wiring shall be numbered and color-coded to match wiring diagram.

4. Install factory wiring outside of an enclosure in a raceway.

5. Field power interface shall be to NEMA KS 1, heavy-duty, non-fused disconnect switch.

6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
   a. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

7. Provide each motor with overcurrent protection.

8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.


10. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
11. Control Relays: Auxiliary and adjustable time-delay relays.
12. Indicate the following for water chiller electrical power supply:
   a. Current, phase to phase, for all three phases.
   b. Voltage, phase to phase and phase to neutral for all three phases.
   c. Three-phase real power (kilowatts).
   d. Three-phase reactive power (kilovolt amperes reactive).
   e. Power factor.
   f. Running log of total power versus time (kilowatt hours).
   g. Fault log, with time and date of each.

L. Controls:

6. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
   a. Hardwired Points:
      1) Monitoring: On-off status, common trouble alarm, electrical power demand, electrical power consumption (kilowatt-hours), power factor.
      2) Control: On-off operation, chilled-water, discharge temperature set-point adjustment, electrical power demand limit.
   b. ASHRAE 135 BACnet or LonTalk or Modbus (Coordinate with Section 23 0900 “Building Automation System”) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

M. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 3/4 inch.
3. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. Factory-applied insulation over cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
   a. Apply adhesive to 100 percent of insulation contact surface.
   b. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
   c. Seal seams and joints to provide a vapor barrier.
   d. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Apply protective coating to exposed surfaces of insulation.

U. Accessories:
BYU MOTION PICTURE STUDIO
CHILLER PLANT

1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.

V. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

X. Capacities and Characteristics:

1. Capacities and characteristics shall be as scheduled on the Drawings.

2.8 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory performance test water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

1. Test the following conditions:
   a. Design conditions indicated.
   b. Reduction in capacity from design to minimum load in steps of 25 percent with condenser fluid at design conditions.

3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

E. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

1. Test the following conditions:
   a. Design conditions indicated.
   b. Chiller operating at calculated worst-case sound condition.
   c. At five points of varying part-load performance.

3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and
electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting:

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with anchor bolt sizes, concrete base thickness and anchor bolt edge setback requirements as required by Section 230248 “Vibration Isolation and Seismic Restraint.”

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to chiller to allow service and maintenance.

D. Evaporator and Condenser Fluid Connections: Connect to evaporator inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a mechanical coupling [flange] [flange or mechanical coupling].

F. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

3.4 CLEANING

A. After completing installation, including outlet fittings and devices; inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match
original finish.

3.5 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that thermometers and gages are installed.
4. Operate chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device is vented to a safe location.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare written test and inspection report; startup report; findings; and corrective actions. Submit reports to the Architect.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to adjusting, operating, startup and shutdown; troubleshooting; servicing and preventative maintenance of chillers.

1. Review data in the Operation and Maintenance Manual. Refer to Division 1 Section “Contact Closeout”.
2. Schedule training with Owner through the Architect with at least 14 days advance notice.

END OF SECTION 23 6423
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Propeller unit heaters with coils.

1.3 DEFINITIONS
   A. BAS: Building automation system.

1.4 SUBMITTALS
   A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
   B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      1. Plans, elevations, sections, and details.
      2. Location and size of each field connection.
      3. Details of anchorages and attachments to structure and to supported equipment.
      4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
      5. Location and arrangement of integral controls.
   C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      1. Suspended ceiling components.
      2. Structural members to which unit heaters will be attached.
      3. Method of attaching hangers to building structure.
      4. Size and location of initial access modules for acoustical tile.
      5. Items penetrating finished ceiling, including the following:
         a. Lighting fixtures.
b. Air outlets and inlets.

c. Speakers.

d. Sprinklers.

e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

F. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."


1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish spare filter(s) for each filter installed.
PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

A. Available Manufacturers: Are to be one of the following:
   1. Airtherm; a Mestek Company.
   2. Trane.
   3. Qmark

B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

I. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
   2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

J. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

K. Control Devices:
   1. Fan-speed switch.

PART 3 - EXECUTION

3.1 EXAMINATION
BYU MOTION PICTURE STUDIO  
CHILLER PLANT

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 73 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Suspend propeller unit heaters from structure with all-thread hanger rods. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

F. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Duct Accessories."

B. Ground equipment according to Division 29 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

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

B. Perform the following field tests and inspections and prepare test reports:

   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

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

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 238240
SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Raceways.
5. Grout.
6. Common electrical installation requirements.
7. Concrete equipment bases.
8. Building wire and connectors.
10. Electrical identification.
11. Electricity-metering components.
12. Cutting and patching for electrical construction.
13. Touchup painting.
14. Workmanship.
15. Coordination drawings.
17. Electrical installations.
18. Cutting and patching.
20. Record documents.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.
C. PVC: Polyvinyl chloride.
D. OSHA: Occupational Safety and Health Administration.
F. EPA: Environmental Protection Agency
BYU MOTION PICTURE STUDIO
CHILLER PLANT

G. KW: Kilo watts.

H. NECA: National Electrical Contractor Association

I. EMT: Electrical metallic tubing.

J. FMC: Flexible metal conduit.

K. IMC: Intermediate metal conduit.

L. LFMC: Liquidtight flexible metal conduit.

M. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

B. Product Data: Follow the procedure specified in Division 1 Section “Submittals”.

C. Shop Drawings: Dimensioned plans and sections or elevation layouts of electrical equipment.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Additional copies may be required by individual sections of these Specifications.

F. Prepare coordination drawings in accordance with Division 1 Section “Project Coordination”, to a scale of $\frac{1}{4}"=1'-0"$, or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installation, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

5. Clearance for servicing equipment, including space for equipment disassembly required for periodic maintenance.


7. Fire rated wall and floor penetrations.

8. Equipment connections and support details.

9. Sizes and location of required concrete pad and bases.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

D. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

G. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

H. Verify voltage, phase and amps of all equipment, prior to rough-in phase of project.

I. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

J. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

K. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

L. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than five working days in advance of proposed interruption of electric service.

2. The Owner must schedule interruptions of services when Contractor wishes to make utility connections. Interruption will be at the Owners convenience. Overtime, if required for this work, will be at the contractor's expense.

3. Prior to placing a full load on any new or modified electric service, the Owner shall be notified and the activation of the full load into this service will be at a time agreeable to the Owner and under the supervision of Owner personnel.
M. Owner will not provide, connect or otherwise perform any services without specific prior agreement.

1.7 WORKMANSHIP

A. All materials and equipment shall be installed in accordance with the recommendations of the manufacturer to conform to the contract documents. The installation shall be accomplished by workmen skilled in the type of work involved.

B. The Electrical Contractor shall have a licensed or certified Master Electrician assigned to direct the electrical work and to coordinate work with the General Contractor and other trades. Furthermore, a licensed or certified journeyman electrician shall be assigned to supervise the actual performance of all electrical work under Division 26. All installers must be certified journeyman.

1. All workmen doing electrical work of any nature must at all times carry their electrician's license with them and show it upon request.

2. The licensed or certified journeyman assigned to supervise the performance of Division 26 electrical work, shall be required to be on the job site at all times, while Division 26 work is being performed.

C. The installation shall conform to the applicable rules of the National Electrical Code and National Electrical Safety Code except where more stringent requirements are noted in these specifications. Conflicts shall be brought to the attention of the Architect/Engineer.

D. The Contractor and Sub-contractors shall comply with OSHA and EPA Standards while in the performance of this contract.

1.8 SUBSTITUTIONS

A. The equipment specified carries brand names and catalog numbers and shall be interpreted as establishing a standard of quality. Use only specified items or those listed by addenda.

B. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier, who shall bear all costs required to make the equipment comply with the intent of the plans and specifications.

C. At the option of the Architect/Engineer, samples may be required for non-standard items before installation during construction.

D. No materials or apparatus shall be substituted after the bid opening except where the equipment manufacturer has been discontinued or delivery becomes a problem, then written approval of the Architect/Engineer is required.

1.9 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, indicate installed conditions for:
1. Major raceway systems, size, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Each submittal pages shall be stamped with the current date.

4. Identify which items on submittal sheets are included in the project.

5. The Owner will not conduct a final inspection without prior delivery of performance data, spare parts lists, operating instructions and equipment descriptive literature that contains complete numbered replacement parts list.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. PVC Pipe Sleeves: Schedule 40, PVC, plain ends.

C. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: As required to match the specified roof material interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.


4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FIRE RATED ASSEMBLIES

A. Fire-Rated Assemblies: Install UL approved fire rated assemblies for penetration of fire-rated floor and wall areas unless openings are compatible with firestop system used during fabricated and construction of floors or walls. Use of conduits through fire rated area penetrations shall not be permitted.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

D. Right of Way: Give to piping systems installed at a required slope.

E. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

F. All new direct buried conduits and/or duct banks shall be surveyed, prior to backfilling. The Owner's civil engineer shall perform all surveying. Sufficient notice shall be given to civil engineer to perform their surveying responsibilities.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

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

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, for all floor mounted equipment and enclosures. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 4000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete." Follow equipment manufacturer's current written anchorage recommendations and setting templates for anchor-bolt and tie locations unless otherwise indicated.

3.5 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

F. Contractor shall remove lamps and ballasts from the existing light fixtures and dispose them in the owner furnished containers.

3.6 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

C. Repair conduit and system that have been disturbed or broken, see 3.6B.

3.7 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
4. Electrical identification.
5. Cutting and patching for electrical construction.
6. Touchup painting.

B. Infrared Scanning: After Substantial Completion but not more than 60 days after Final Acceptance perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected remedial action taken and observations after remedial action.

3.8 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

3.9 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260500
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:
1. None

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.
C. NFPA: National Fire Prevention Association
D. ASTM: American Society for Testing and Materials
E. NEMA: National electrical Manufacturers Association
F. NETA: National Educational Telecommunications Association

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency.
C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. General Cable Corporation.
5. Cerro Wire.

B. Refer to Part 3 “Conductor Insulation and Multiconductor Cable Applications and Wiring Methods” Article for insulation type, cable construction and ratings.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Material: Copper complying with NEMA WC 5 stranded conductor. Aluminum conductors are not allowed on this project.

E. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

F. Minimum Conductor Size (power conductors): #12 AWG, except for low voltage signal fire alarm and intercom systems, then only as approved by the Owner.

G. MC-Cable or Romex cables shall not be allowed in this project.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
C. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

D. Conductor Material: Copper complying with NEMA WC 5 stranded conductor. Aluminum conductors are not allowed on this project.

E. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

F. MC and NM (Romex) cables shall not be used on this project.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: As required for the specified materials interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded for all conductor sizes, unless otherwise indicated.

B. Branch Circuits: Copper. Stranded for all conductor sizes, unless otherwise indicated.

C. Aluminum conductors are not allowed on this project.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

J. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

K. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway.

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

M. Fire Alarm Circuits: Type THHN-THWN, in single raceway, unless specified otherwise in Section 28, "Digital, Addressable Fire Alarm System".

N. Class 1 Control Circuits: Type THHN-THWN, in raceway.
O. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

H. Clean conduits with an approved mandrel, as specified in Division 26 Section 260533, prior to installing conductors.

3.4 CONNECTIONS

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

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

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

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Utility Areas. Extend sleeves installed in floors 2 inches above finished floor level.

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

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTopping

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.


C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:

1. Overhead-lines grounding.
2. Underground distribution grounding.
3. Underground utility duct banks.
4. Common ground bonding with lightning protection system.

B. Related Sections include the following: NONE

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with UL 467 for grounding and bonding materials and equipment.
C. Comply with NFPA 70; for medium-voltage underground construction, comply with IEEE C2.
D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:
   a. Chance/Hubbell.
   b. Copperweld Corp.
   c. Erico Inc.; Electrical Products Group.
   d. Framatome Connectors/Burndy Electrical.
   e. Harger Lightning Protection, Inc.
   f. Heary Brothers Lightning Protection Co.
   g. Kearney/Cooper Power Systems.
   h. Korns: C. C. Korns Co.; Division of Robroy Industries.
   i. Lyncole XIT Grounding.
   k. Raco, Inc.; Division of Hubbell.
   l. Thomas & Betts, Electrical.

2.2 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
B. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 GROUNDING BUS

A. Rectangular bars of annealed copper, 1/4 by 4 inches by 14 inches in cross section, unless otherwise indicated; with insulators.
2.4 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Irreversible Crimp Connectors: Irreversible crimp kits with types of crimp connectors recommended by kit manufacturer for materials being joined and installation conditions.

2.5 GROUNDING RODS AND ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet in diameter.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with non-hazardous electrolytic chemical salts.
   1. Termination: Field-attached AWG bare conductor. Provide at least 24 inches long tail.
   2. Backfill Material: Electrode manufacturers recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Stranded for all conductor sizes, unless otherwise indicated.

B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. In all raceways, use insulated equipment grounding conductors.

D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
3.2 FEEDER AND BRANCH CIRCUIT SYSTEMS
A. Install insulated equipment grounding conductors with all feeders and branch circuits.

3.3 EQUIPMENT GROUNDING
A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
B. Install insulated equipment grounding conductors with all feeders and branch circuits.
C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Armored and metal-clad cable runs.
   8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
D. Computer Outlet Circuits: Install insulated equipment-grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
E. Nonmetallic Raceways: Install an equipment-grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
F. Air-Duct Equipment Circuits: Install an equipment-grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
G. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment-grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
H. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
I. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from...
panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

J. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, ground bar, terminal cabinet, wiring closet, and central equipment location.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

K. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bury all grounding conductors at least 24-inches below grade.

C. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

D. Ground Rods:
1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
3. Use a #6 AWG ground conductor for all ground rods, unless noted otherwise.
4. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
5. Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

E. Underground Duct Bank Grounding Conductors:
1. Install bare copper conductor, No. 2 AWG minimum or as shown on the plans.
2. Communication duct banks.
   a. Provide (1) grounding conductor, incorporated into each duct bank.
3. Power duct banks.
a. Provide (2) two grounding conductors, incorporated into each duct bank. One conductor at opposite top corners or sides tied to rebar at appropriate intervals.

F. Counterpoise:
1. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart.
2. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building.
3. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for tap to building steel.
4. Bury counterpoise not less than 24 inches below grade and 24 inches from building foundation.

G. Ground Ring System:
2. Bury at least 24 inches below.
3. Minimum conductor length shall be 20 feet.

H. UFER Ground (Concrete-Encased Grounding Electrode):
1. Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
2. Provide UFER grounding systems for new service entrances, transformers, generator pads and all medium voltage duct banks.
3. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
4. Concrete slabs and foundations.
   a. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts.
   b. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.
5. Power and Communication duct banks.
   a. UFER grounds installed within power and communication duct banks shall be a minimum #2 AWG bare copper conductor.
   b. Power Duct Banks.
      1) Applied grounding system in parallel, located in opposite top corners or sides, run the entire length of the duct bank, tied to rebar at appropriate intervals, and connected to a common grounding electrode plate located at vault or pad at each end of the runs.
   c. Communication Duct Banks.
      1) Applied grounding system in parallel, located in opposite top corners or sides, run the entire length of the duct bank, tied to rebar at appropriate intervals, and connected to a common grounding electrode plate located at vault or pad at each end of the runs.

I. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

J. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building.
2. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
3. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

K. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

L. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

M. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

3.5 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING
A. Comply with IEEE C2 grounding requirements.

3.6 CONNECTIONS
A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors with at least two bolts.
5. Connections to Structural Steel: Welded connectors.
7. Chemical-Enhanced Grounding Electrodes: Bolted connectors with at least two bolts.

C. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

G. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

H. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

I. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order,
and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
5. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
  1. Hangers and supports for electrical equipment and systems.
  2. Construction requirements for concrete bases.
B. Related Sections include the following:
  1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS
A. Product Data: For the following:
BYU MOTION PICTURE STUDIO
CHILLER PLANT

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

1.7 COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.
B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. Fabco Plastics Wholesale Limited.
      d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. **Verify suitability of fasteners in subparagraph below for use in lightweight concrete or concrete slabs less than 4 inches thick.**

2. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

3. Mechanical-Expansion Anchors: Insert-wedge-type, **zinc-coated** steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

4. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
5. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
7. Toggle Bolts: All-steel springhead type.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

B. Support structure width shall be 24 inches (min), unless specified otherwise. For shorter widths, obtain permission from the Owners engineer, prior to installation.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.
Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
3.5 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 minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
B. Related Sections include the following:
   1. Division 26 Section "Identifications of Electrical Systems" for identification of conduit, boxes, exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. EPDM: Ethylene-propylene-diene terpolymer rubber.
D. FMC: Flexible metal conduit.
E. IMC: Intermediate metal conduit.
F. LFMC: Liquidtight flexible metal conduit.
G. LFNC: Liquidtight flexible nonmetallic conduit.
H. NBR: Acrylonitrile-butadiene rubber.
I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.
   2. For handholes and boxes for underground wiring, including the following:
a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.
c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
7. Maverick Tube Corporation.
10. Western Conduit.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   2. Fittings for EMT:
      a. Steel, set-screw type in interior/dry locations.
      b. Utilize steel, compression type in damp or exterior locations.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.
   4. CANTEX Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
BYU MOTION PICTURE STUDIO  
CHILLER PLANT

10. Manhattan/CDT/Cole-Flex.  
11. RACO; a Hubbell Company.  
12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.  

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.  

D. LFNC: UL 1660.  

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.  

F. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
   1. Cooper B-Line, Inc.  
   2. Hoffman.  
   3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.  

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.  

D. Wireway Covers: **Hinged type** Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
   1. Hoffman.  
   2. Lamson & Sessions; Carlon Electrical Products.

B. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.  

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect/Engineer.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Thomas & Betts Corporation.
   c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Butler Manufacturing Company; Walker Division.
      b. Enduro Systems, Inc.; Composite Products Division.
      c. Hubbell Incorporated; Wiring Device-Kellems Division.
      d. Lamson & Sessions; Carlon Electrical Products.
      e. Panduit Corp.
      g. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   7. RACO; a Hubbell Company.
   10. Spring City Electrical Manufacturing Company.
   14. Randl Industries, Inc. (data box only).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

2.7 DATA (COMMUNICATION) BOXES

A. Data Box Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Data box.
      a. Randl Industries, Inc.
      b. Siemon
      c. No alternate manufacturers approved.
   2. Description. Model number #T-55018, 5” sq, 2-7/8" deep, (1) 3/4" and (1) 1" knockout each on three sides, (1) 1/2" knockout on the back. No approved equivalent boxes.
   3. Extension rings.
      a. Two gang extension ring. Randl, No approved equivalent boxes. Single gang extensions are not approved. Use the following extension rings based upon sheetrock thickness.
         1) flat extension, Randl, #L52G000.
         2) 1/2" extension, Randl, #L54G012.
         3) 5/8" extension, Randl, #L54G058.
         4) 3/4" extension, Randl, #L54G034.
         5) 1" extension, Randl, #L54G010.
         6) 1-1/4" extension, Randl, #L54G114.

B. Large Format Data Box Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Data box. For use with conduits 1-1/4" to 2" conduits.
      a. Hubbell Wiring Systems
   2. Description. Model number #HBL263, 4-11/16" high, 7-3/4" wide and 3-1/4" deep. ½" to 2" knockouts each on sides and 1/2" to 1-1/4" knockouts on the back. No approved equivalent boxes.
   3. Extension rings.
      a. Three gang extension ring. Hubbell Wiring Systems. No approved equivalent boxes. Single gang extensions are not approved. Use the following extension rings based upon sheetrock thickness.
         1) 1/2" height, Hubbell, #HBL792.
         2) 3/4" height, Hubbell, #HBL793.
         3) 1-1/4" height, Hubbell, #HBL794.
      b. Low voltage partition.
         1) Hubbell, #HBL981. Compatible with 1/2", 3/4" and 1-1/4" mud ring depths.
2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" as indicated for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation.
   d. NewBasis.
   e. Quazite.

2.9 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.138" thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.10 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.
B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
3. Exposed Conduit: Rigid steel conduit or IMC.
4. Concealed Conduit, Aboveground: Rigid steel conduit or IMC.
5. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
7. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
8. Application of Handholes and Boxes for Underground Wiring:
   a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
   b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units SCTE 77, Tier 8 structural load rating.
   c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Indoor: Apply raceway products as specified below, unless otherwise indicated:
4. Exposed, Not Subject to Physical Damage: EMT.
5. Exposed, Not Subject to Severe Physical Damage: EMT.
6. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:
   a. Loading dock used for traffic of mechanized carts, forklifts, pallet-handling units and trucks backing into the loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
7. Concealed in Ceilings and Interior Walls and Partitions: EMT.
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
9. Damp or Wet Locations: Rigid steel conduit or IMC.
10. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway or EMT.
11. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway or EMT.
12. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: Plenum-type, optical fiber/communications cable raceway or EMT.
13. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

D. Aluminum conduits are not permitted on project.

3.2 INSTALLATION
A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
B. Complete raceway installation before starting conductor installation.
C. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
E. Install manufactured rigid steel conduit elbows for all bends. If manufactured bend angles are not standard, bend rigid steel conduit with equipment manufactured and listed for the use of bending rigid steel conduit. For direct buried areas, wrap rigid steel elbows with PVC tape, provide a minimum of 50% overlap. Extend PVC wrap past end of steel conduit. Extend PVC tape to a distance of 12” above final grade.
F. Install temporary closures to prevent foreign matter from entering raceways.
G. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

H. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

I. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

J. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

K. Raceways Embedded in Slabs are not permitted, unless approved in writing by campus electrical engineer.

L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; LFMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

P. Install no more than the equivalent of (2) two 90-degree bends in any conduit run except for optical fiber and communications conduits.

Q. Raceways for Optical Fiber and Communications (Network) Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 1-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. Larger than 1-Inch Trade Size: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two (2) 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

R. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

S. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
BYU MOTION PICTURE STUDIO
CHILLER PLANT

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

T. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

V. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

W. Set metal floor boxes level and flush with finished floor surface.

X. Join raceways with fittings designed and approved for that purpose and make joints tight.
   1. Use insulating bushings to protect conductors.

Y. Tighten set screws of threadless fittings with suitable tools.

Z. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

AA. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows at vault entrances, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for all bends. Wrap elbows with PVC tape, provide a minimum of 50% overlap. Extend PVC wrap past end of steel conduit.
6. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
D. Install handholes and boxes with bottom below the frost line, below grade.
E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
F. Cut sleeves to length for mounting flush with both surfaces of walls.
G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of raceway systems.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide cylinder style mandrel equal to 80 percent fill of duct as follows:

   a. 2" conduit - Mandrel 1.5" diameter, 4.25" long.
b. 3" conduit - Mandrel 2.75" diameter, 4.25" long.
c. 4" conduit - Mandrel 3.6" diameter, 4.25" long.

3. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

   1. Isolation pads.
   2. Spring isolators.
   3. Restrained spring isolators.
   4. Channel support systems.
   5. Restraint cables.
   6. Hanger rod stiffeners.
   7. Anchorage bushings and washers.

B. Related Sections include the following:

   1. Division 26 Section "Hangers And Supports For Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS


C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

   1. Site Class as Defined in the IBC: D
   2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III

   a. Component Importance Factor: 1.0
   b. Component Response Modification Factor: 1.5
   c. Component Amplification Factor 1.0.

   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): .911g.
4. Design Spectral Response Acceleration at 1.0-Second Period: 0.558g

1.5 SUBMITTALS

A. Product Data: For the following:

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 seismic-restraint component used.
   a. Annotate to indicate application of each product submitted and compliance with requirements.


B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
   a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Field quality-control test reports.

1.6 QUALITY ASSURANCE
A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. This Article is for a UBC project. In coordination with structural engineer, select one of five zone and zone-factor combinations in paragraph below and edit to suit local requirements by interpolation or by making other permissible interpretations of applicable seismic criteria.

B. Project Seismic Zone and Zone Factor as Defined in UBC: Zone 3, Zone Factor 0.30.

C. Select categories and factors in two paragraphs below in coordination with structural engineer.

1.8 PROJECT CONDITIONS

A. This Article is for analysis per BOCA or SBC. Edit to suit actual code or combination of codes that applies. In coordination with structural engineer, refer to code seismic contour map and authorities having jurisdiction for value to insert below.

B. Select group in paragraph below in coordination with Architect or structural engineer.

C. Project Seismic Hazard Exposure Group as Defined in BOCA or SBC.

1.9 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.
PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
4. Isolation Technology, Inc.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.

B. Pads as shown: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. 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.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl 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.

2.3 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Coordinate products in this Article with structural engineer and with Drawings.

B. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

C. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.

D. Concrete Inserts: Steel-channel type.

E. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

F. Welding Lugs: Comply with MSS SP-69, Type 57.

G. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

H. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized.
   3. Hot-dipped galvanize metal components for exterior use.
   5. Baked enamel or powder coat for metal components on isolators for interior use.
   6. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-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.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.

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 will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
   1. Install restrained isolators on electrical equipment.
   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 evaluation service member of ICC-ES providing required submittals for component.

B. 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.

C. 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.

D. 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 structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed 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.

3.4 ELECTRICAL EQUIPMENT ANCHORAGE

A. Anchor rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.

B. Anchor panelboards, motor-control centers, motor controls, switchboards, switchgear, transformers, fused power-circuit devices, transfer switches, busways, battery racks, static uninterruptible power units, power conditioners, capacitor units, communication system components, and electronic signal processing, control, and distribution units as follows:
   1. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
   2. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
   3. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
   4. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

C. STRUCTURAL ATTACHMENTS
   1. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.
   2. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.
   3. Attachments to Existing Concrete: Use expansion anchors.
   4. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
   5. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
   6. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
   7. Attachments to Wood Structural Members: Install bolts through members.
   8. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.
3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Remove and replace malfunctioning units and retest as specified above.
   1. Provide necessary test equipment required for reliable testing.
   2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   3. Retain subparagraphs below with any paragraph selected above.
   4. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
   5. Obtain Architect's approval before transmitting test loads to the structure. Provide temporary load-spreading members.
   6. Edit sampling frequency in subparagraph below to suit Project.
   7. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   8. Test to 90 percent of rated proof load of device.
   9. If a device fails the test, modify all installations of same type and retest until satisfactory results are achieved.
   10. Record test results.

3.7 ADJUSTING

A. Adjust isolators after isolated equipment 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.
C. Adjust active height of spring isolators.
D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.8 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment:
   1. Equipment Location: as required.
2. Pads:
   b. Thickness: ¼ inches.

3. Isolator Type: As designated in Part 2.
4. Component Importance Factor: 1.0
5. Component Response Modification Factor: 1.5
6. Component Amplification Factor: 1.0

END OF SECTION 260548
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
5. Wiring devices.
6. Warning labels and signs.
7. Handicapped door operators.
8. Instruction signs.
10. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products, as requested by owner.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE


B. Comply with NFPA 70.


D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices, marking or stickers with completion of covering and painting of surfaces, where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices, marking or stickers, before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Raceway identification materials for raceways Carrying Circuits at 600 V or Less:
   1. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
   2. Paint: Formulated for the type of surface and intended use.
      b. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
      c. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
      d. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

C. Raceway identification materials for raceways Carrying Circuits at More Than 600 V:
   2. Legend: "DANGER - HIGH VOLTAGE"

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Raceway identification materials for raceways Carrying Circuits at 600 V or Less:
1. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

2. Paint: Formulated for the type of surface and intended use.
   b. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
   c. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
   d. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

C. Colors for Raceways Carrying Circuits at More Than 600 V:
   1. Armored or metal-clad cables are not approved for voltages over 600V.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Power cables:

C. Control cables:
   1. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
   2. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
      a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   3. Hand held machine-printed, white, indented adhesive labels, configured for display on control cable ends and in all pull boxes, unless otherwise indicated.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape, not less than 3 mils thick by 1 to 2 inches wide.

2.5 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type ID (warning tape with metal core):

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.7 WIRING DEVICES

A. Self-Adhesive Labels: Label machine printed, clear with black letters, pressure-sensitive adhesive labels, configured for display on top of device cover, unless otherwise indicated. Provide a single line of text with 1/4-inch-high letters on 1/2-inch-high label; where two lines of text are required, use labels 1 inches high or two, stacked labels.

2.8 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

D. Baked-Enamel Warning Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR:"
   a. Working Voltage 208V: 36 inches.
   b. Working Voltage 480V: 48 inches.
   c. Working Voltage 4,160V: 60 inches.
   d. Working Voltage 12,470V: 10 feet.
   e. Working Voltage 46,000V: 10 feet.

2.9 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.10 EQUIPMENT IDENTIFICATION LABELS


2.11 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

C. Paint: Formulated for the type of surface and intended use.
   1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
   2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
   3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
   4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
F. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
   1. Raceway Bands: Paint conduit with a color band 2 inches wide (min.), completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
   2. Cable Bands: Paint conduit each color band 2 inches wide (min.), completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
   3. Locations: At each junction or pull box, at penetrations of walls and floors, at 10-foot maximum intervals in straight runs, and at 5-foot maximum intervals in congested areas.
   4. Apply the following banding colors to the systems listed below:
      b. Fire-Suppression Supervisory and Control System: Red and Yellow.
      c. Security System: Purple
      d. Mechanical and Electrical Supervisory System: Green and Blue.
      e. Telecommunications System: Blue
      f. Emergency/UPS power system: Yellow.
      g. 277/480 volts system: Brown.
      h. 120/208 volts system: Black.
      i. Clocks & Bells: Orange.
      j. Sound System: Green.
      k. Traveler (switch to light or switch to switch) 120 volts: Pink and Black.
      l. Traveler (switch to light or switch to switch) 277 volts: Pink and Brown.
      m. Lighting control and dimmers systems: White.

G. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

K. Painted Identification: Comply with the following requirements for surface preparation and paint application.
   1. Paint: Formulated for the type of surface and intended use.
   3. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
   4. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
   5. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

L. Circuit Identification Labels on Boxes: Install circuit identification on the inside of each junction and pull box cover.
   1. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
3.2 HANDICAPPED DOOR OPERATORS

A. Provide labeling for maintenance workers inside of accessible panels. Labeling shall include the following:
   1. Identify location of panel feeding door operator.
   2. Identify panel name and circuit number.

3.3 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Install self-adhesive labels on 10-foot centers over the full length of the raceway or duct. The labels shall read "DANGER - HIGH VOLTAGE". Apply to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits: Paint conduit with a color band 2 inches wide (min.), completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install labels at 10-foot maximum intervals.

C. Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits: Paint conduit with a color band 2 inches wide (min.), completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install labels at 10-foot maximum intervals.

D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Fire-Alarm System.
   2. Fire-Suppression Supervisory and Control System.
   4. Mechanical and Electrical Supervisory System.
   5. Telecommunications System.
   6. Emergency/UPS power system.
   7. 277/480 volts system.
   8. 120/208 volts system.
   10. Sound System.
   11. Traveler (switch to light or switch to switch) 120 volts.
   12. Traveler (switch to light or switch to switch) 277 volts.
   13. Lighting control and dimmers systems.

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
      b. Colors for 208/120-V Circuits:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral: White
5) Ground: Green

c. 480/277-V Conductors:
1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.
4) Neutral: Gray
5) Ground: Green

2. Color-Coding for Phase and Voltage Level Identification, More than 600 V: Use colors listed below for all cables.
   a. Colors for over 600-V circuits:
   1) Phase A: Orange.
   2) Phase B: Red.
   3) Phase C: Blue.

F. Fire Alarm-Circuit Conductor Identification, 600 V or Less: See Specification Section 283111 for required, permanent color coding of fire alarm conductors.

G. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes; use color coded adhesive tape.

I. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

J. Apply identification to conductors as follows:
   1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
   2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits’ voltage and phase.
   3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

K. Apply warning, caution, and instruction signs as follows:
   1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
   2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

L. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
M. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

N. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for direct-buried cables, cables in raceway/underground ducts and ductbanks.

O. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

P. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.

Q. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

R. Conductors for bells, clocks, intercommunication systems and alarm circuits shall be identified at all junction or terminal blocks with plastic tags attached with waxed linen cord. Lettering on the tag shall be made with a wax pencil, covered with one coat of spray lacquer. Information on the tag shall include name of circuit and area served.

S. Receptacles Identification Labels: On each power receptacle, install unique designation label that states the panel and circuit breaker source. Clean device cover prior to installing label.

T. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, attached with stainless steel screws.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:
   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved label.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
   d. Switchgear.
   e. Switchboards.
   f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   g. Substations.
   h. Variable-speed controllers.
   i. Power transfer equipment.
   j. Panelboards, electrical cabinets, and enclosures.
   k. Access doors and panels for concealed electrical items.
   l. Disconnect switches.
   m. Control devices.

END OF SECTION 260553
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Load centers.
   4. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. 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.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than five working days in advance of proposed interruption of electric service.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.
Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spare for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Siemens Energy & Automation, Inc.
2. Square D; a brand of Schneider Electric.

C. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Outdoor Locations: NEMA 250, Type 3R.
   c. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
   d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
   a. Panels and Trim: Steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Same finish as panels and trim.

D. Incoming Mains Location: **Bottom**

E. Phase, Neutral, and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
   4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
   5. Split Bus: Vertical buses divided into individual vertical sections.

F. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Main and Neutral Lugs: Mechanical type.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

G. Service Equipment Label: UL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

H. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
2.2 PANELBOARD SHORT-CIRCUIT RATING

   1. Lighting and appliance branch-circuit panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an UL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an UL.

2.3 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.
B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches high, provide two latches, keyed alike.
C. Mains: As specified on drawings
E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
F. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
B. Mains: As specified on the drawings.
C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
   2. External Control-Power Source: 120-V branch circuit.
E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
   f. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
   g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
   h. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
   i. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
   j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
   k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
   1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
   2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
   3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.
   1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Mount top of trim 74 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical System”.

B. Connect wiring according to Division 26 Section “Low-voltage Electrical Power Conductors and Cables”.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
D. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

E. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416
SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
5. Isolated-ground receptacles.
6. Hospital-grade receptacles.
7. Hazardous (classified) receptacles.
8. Snap switches and wall-box dimmers.
10. Wall-switch and exterior occupancy sensors.
11. Communications outlets.
13. Cord and plug sets.
14. Pin and sleeve sets.
15. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:

1. Division 26 Section "Identifications of Electrical Systems" for identification of receptacle and device circuiting.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
D. RFI: Radio-frequency interference.
E. TVSS: Transient voltage surge suppressor.
F. UTP: Unshielded twisted pair.
1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

B. Receptacles for new equipment:
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers’ Names: Shortened versions (shown in parentheses) of the following manufacturers’ names are used in other Part 2 articles:
   1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Provide devices with back and side wiring.

   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   2. Products: Subject to compliance with requirements, provide one of the following:
2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; GF20LA.
      b. Leviton; 7899.
      c. Pass & Seymour; 2095-S.

C. Duplex GFCI Convenience Receptacles, 125 V, 20 A, Tamper Resistant:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; GFTR20.
      b. Leviton; T7899.
      c. Pass & Seymour; 2095TR.

2.4 SURGE PROTECTIVE DEVICE

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449 (3rd Edition), with integral SPD in line to ground, line to neutral, and neutral to ground.
   1. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   2. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex SPD Convenience Receptacles:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   2. Products: Subject to compliance with requirements, provide one of the following:
BYU MOTION PICTURE STUDIO
CHILLER PLANT

2.5 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.6 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
   b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
   c. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), PS20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1221PL for 120 V and 277 V (single pole) and HBL1223PL for 120V and 277V (three way).
   b. Leviton; 1221-PLR for 120 V (single pole), 1221-7PLR for 277 V (single pole); 1223-PLR for 120 V (three way), 1223-7PLR for 277 V (three way).
   c. Pass & Seymour; PS20AC1-RPL (single pole) for 120 V, PS20AC1-RPL7 for 277 V (single pole); PS20AC3-RPL for 120 V (three way), PS20AC3-RPL7 for 277 V (three way).
3. **Description:** Single pole, with neon-lighted handle, illuminated when switch is "ON."

4. **Lamp color:** Red.

**D. Lighted Toggle Light Switches, 20 A:**

1. **Available Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. **Products:** Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1221L for 120 V and 277 V (single pole) and HBL1223L for 120V and 277V (three way).
   b. Leviton; 1221-PLR for 120 V (single pole), 1221-7PLR for 277 V (single pole); 1223-PLR for 120 V (three way), 1223-7PLR for 277 V (three way).
   c. Pass & Seymour; PS20AC1-CSL (single pole) and PS20AC3-CSL (three way).

3. **Description:** Single pole, with neon-lighted handle, illuminated when switch is "OFF."

4. **Lamp color:** Red.

**E. Key-Operated Switches, 120/277 V, 20 A:**

1. **Available Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. **Products:** Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1221L (single pole), HBL1223L (three way) and HBL1224L (four way).
   b. Leviton; 1221-2L (single pole), 1223-2L (three way) and 1224-2L (four way).
   c. Pass & Seymour; PS20AC1XL (single pole), PS20AC3XL (three way) and PS20AC4XL (four way).

3. **Description:** Single pole, with factory-supplied key in lieu of switch handle.

**F. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors:**

1. **Available Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. **Products:** Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1557.
   b. Leviton; 1285.
   c. Pass & Seymour; 1225.

**G. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle:**
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

   a. Hubbell; HBL1557L.

   b. Leviton; 1285L.

   c. Pass & Seymour; 1225L.

2.7 WALL PLATES

   A. Single and combination types to match corresponding wiring devices.

   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, 302/304 stainless steel.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

   B. Wet-Location, Weatherproof Cover Plates:

      1. NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.8 FINISHES

   A. Color: Wiring device catalog numbers in Section Text do not designate device color.

      1. Wiring Devices Connected to Normal Power System: Gray, unless otherwise indicated or required by NFPA 70 or device listing.
      3. TVSS Devices: Blue.
      4. Isolated-Ground Receptacles: Gray with an Orange triangle representing and isolated ground device.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

   B. Coordination with Other Trades:

      1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use engraved machine printing with white-filled lettering on face of black plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726