University of Colorado
Anschutz Medical Campus

Perinatal Research Facility - Power HVAC Boiler Upgrades
Project Number 23-110899

PROJECT MANUAL

Issued for Construction
10/30/23

MEP ENGINEERING INC.
CLIENT CENTRIC CONSULTING

MEP ENGINEERING, INC.

6402 S. Troy Circle, Ste 100

Centennial, CO 80111

MEP Project #22318

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DIVISION 01 - GENERAL REQUIREMENTS

DIVISION 02 - EXISTING CONDITIONS

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SECTION 00 01 04 – PROJECT DIRECTORY

PART 1 - GENERAL

1.1 PROJECT DIRECTORY

A. OWNER/UNIVERSITY

University of Colorado Denver | Anschutz Medical Campus
Campus Services, Mail Stop F418
1945 Wheeling Street, Rm 334
Aurora, CO 80045

Robert Holzwarth
robert.holzwarth@cuanschutz.com
(720) 854-4664

B. ARCHITECT

Bret Johnson Architecture
5475 Peoria Street, Unit 3-102
Denver, CO 80239

Bret Johnson, AIA
bret@bretjohnsonarchitecture.com
(720) 341-0392

C. ENGINEERS

MEP Engineering Inc.
6402 S. Troy Circle, Suite 100
Centennial, CO 80111

Karena Broman-Ballas
karena@mep-eng.com
(303) 936-1633 x323

MEP Engineering Inc.
6402 S. Troy Circle, Suite 100
Centennial, CO 80111

Roger Crawford
roger@mep-eng.com
(303) 936-1633 x301

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 01 04

SECTION 00 11 00 – ADVERTISEMENT FOR BIDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section incudes administrative and procedural requirements for project advertisement

1.3 DEFINITIONS

A. ADVERTISEMENT: Posting of project description, requirements, schedule, and related requirements necessary to solicit submittals from contractors.

1.4 ADVERTISEMENT

A. FORM: State of Colorado form “Advertisement for Bids for Contractor’s Agreement Design/Bid/Build” (OSA-AFB-1)

B. A copy of the above noted form is attached at the end of this section.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 11 00

ADVERTISEMENT FOR BIDS General Contractor
State of Colorado
University of Colorado | Anschutz Medical Campus (GFE)
Notice Number: 23-110889

Notice Status:	**OPEN**
Publish Date:	October 30, 2023
# Notice Revisions:	**N/A**
Revision Publish Date:	**N/A**

Project No:	**23-110889**
Project Title:	**PERINATAL RESEARCH FACILITY POWER HVAC BOILER UPGRADES**
Estimated Construction Cost:	**$850,000 - $930,000**

Settlement Notices

For all projects with a total dollar value above $150,000 Notice of Final Settlement is required by C.R.S. 38-26-107(1).
Final Settlement, if required, will be advertised via: Electronic Media

Project Description

The extent of the project will include replacement and upgrades to various building systems identified below:

- Replace penthouse air handling unit (PH-1) in its entirety. This will include replacement and reuse of existing hydronic components currently located in the boiler room section of unit and its related equipment.
- Replacement of the existing Bryan Steam Boiler with new.
    - This will include replacement of the boiler and modifications to the existing system to remove abandoned heat exchangers that were originally used to provide hydronic heating. The new system will be modified to serve only the steam needs of the entire building.
- Utilize an existing 480/3 phase generator on site and provide new generator power distribution equipment tied to existing main building power system.
    - New generator power distribution will be provided to feed new freezer generator loads required by owner including allowance for future freezers.

Scope of Services

The University of Colorado Anschutz Medical Campus is using a design/bid/build delivery approach to provide construction services for this project. This project is intended to be bid by interested and qualified general contractors and will include specialty subcontractors. A contractor's Agreement Design/Bid/Build (D/B/B) State Form SC-6.21 (State of Colorado, Office of the State Architect, State

Building Program) will be utilized. This is a Prevailing Wage Public Project under requirements of passed Senate Bill 19-196.

Minimum Requirements

Notice is hereby given to all interested parties that all firms will be required to meet all minimum requirements to be considered for this project. To be considered as qualified, interested firms shall have, as a minimum:

1. Provided General Contracting services within the last three (3) years for at least three (3) projects each in excess of $1,000,000 (hard costs), utilizing the expertise present in their Colorado Office; and

2. Demonstrated specific General Contracting experience in projects of similar scope and complexity; and

3. Demonstrated bonding capability up to $2,000,000 for an individual project coincidentally with current and anticipated workloads; provide letter from surety that affirms this capacity.

Firms meeting the minimum requirements may obtain the bidding documents on the website accompanying this advertisement.

University of Colorado Denver | Anschutz Medical Campus Facilities Projects – **Request for Proposals** website:
http://www.cuanschutz.edu/offices/facilities-management/construction-projects/RFP

Colorado CORE/ColoradoVSS:
https://codpa-vss.cloud.cgifederal.com/webapp/PRDVSS2X1/AltSelfService

Other Information

Preference shall be given to Colorado resident bidders and for Colorado labor, as provided by law.

Pre-Bid Meeting

A mandatory Pre-Bid Meeting will be held:

University of Colorado | Anschutz Medical Campus

Perinatal Research Facility- 13243 East 23rd Ave, Aurora, CO 80045 (23rd and Victor) Go to Front Entrance Lobby

Comments: **Pre-Bid meeting will begin at *(time)*__10:00____AM on *(date)*__11/06/2023____.**

Schedule/Submission Details

1. The schedule of events for the RFP process and an outline of the schedule for the balance of the project is as follows:

Advertisement	10/30/23
Mandatory Pre-Bid Conference and Tour	11/06/2023,10:00AM

Date Email Questions Due	11/14/2023 2:00PM
Date Email Answers Issued	11/21/2023
Sealed Bids Due/Public Bid Opening	11/30/2023 2:00PM
Negotiation of General Contractor Contract	12/04/2023
Contract Approval (projected)	12/18/2023
Anticipated Design Start	Complete
General Contractor Start	12/18/2023
Construction Start	7/08/2024
Construction Finish	9/30/2024

2. **One (1)** electronic copy PDF of this bid is due *11/30/2023* and shall be received no later than 2:00 *PM (MD/ST)* and shall be submitted via the following website

   http://www.ucdenverdata.formstack.com/forms/rfp_rfq_submission

Comments: **Late sealed bids will be rejected without consideration. The University of Colorado Anschutz Medical Campus and the State of Colorado assume no responsibility for costs related to the preparation of bid submittals.**

3. The above schedule is tentative. Responding firms shall be notified of revisions in a timely manner by email. Respondents may elect to verify times and dates by email, but no earlier than 36 hours before the schedule date and time.

Point of Contact/Clarification

Name:	**Robert Holzwarth**
Agency:	University of Colorado | Anschutz Medical Campus (GFE)
Phone:	(720) 854-4664
Email:	Robert.holzwarth@cuanschutz.edu

This Notice is also available on the web at www.colorado.gov/pacific/osa/cdnotices

Media of Publicaiont(s): **University of Colorado Denver Facilities Projects Website**
Colorado CORE/ColoradoVSS

Publication Dates: 10/30/23

SECTION 00 21 13 – INFORMATION TO BIDDERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 INFORMATION TO BIDDERS

A. State of Colorado form “Information to Bidders” (SBP-6.12).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 21 13

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAMS

INFORMATION FOR BIDDERS

Institution or Agency: University of Colorado Anschutz Medical Campus
Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

1. **BID FORM:** Bidders are required to use the Bid form attached to the bidding documents. Each bidder is required to bid on all alternates and unit prices if shown in construction documents. The bid shall not be modified or conditioned in any manner. Bids must be submitted electronically bearing the address and information shown below.

   Project # 23-110899
   Project Name – Perinatal Research Facility – Power, HVAC, Boiler Upgrades
   Name and Address of Bidder – (Bidder to complete this information)
   Date of Opening - November 30, 2023
   Time of Opening – 2:00 PM

2. **INCONSISTENCIES AND OMISSIONS:** Bidders may request clarification of any seeming inconsistencies, or matters seeming to require explanation, in the bidding documents at least three (3) business days prior to the time set for the opening of Bids. Decisions of major importance on such matters will be issued in the form of addendum.

3. **APPLICABLE LAWS AND REGULATIONS:** The bidder's attention is called to the fact that all work under this Contract shall comply with the provisions of all state and local laws, approved state building codes, ordinances and regulations which might in any manner affect the work to be done or those to be employed in or about the work. Attention is also called to the fact that the use of labor for work shall be governed by the provisions of Colorado law which are hereinafter set forth in Articles 27 and 52E of the GENERAL CONDITIONS.

4. **UNAUTHORIZED IMMIGRANTS:** Note that the Special Provisions of the General Conditions of the Contract includes the following language: PUBLIC CONTRACTS FOR SERVICES - CRS 8-17.5-101 and PUBLIC CONTRACTS WITH NATURAL PERSONS - 24-76.5-101. The Contractor certifies that the Contractor shall comply with the provisions of CRS 8-17.5-101 et seq. The Contractor shall not knowingly employ or contract with an illegal alien to perform work under this contract or enter into a contract with a subcontractor that fails to certify to the Contractor that the subcontractor shall not knowingly employ or contract with an illegal alien to perform work under this contract. The Contractor represents, warrants, and agrees that it (i) has verified that it does not employ any illegal aliens, through participation in the Basic Pilot Employment Verification Program administered by the Social Security Administration and Department of Homeland Security, and (ii) otherwise will comply with the requirements of CRS 8-17.5-102(2)(b). The Contractor shall comply with all reasonable requests made in the course of an investigation under CRS 8-17.5-102 by the Colorado Department of Labor and Employment. If the Contractor fails to comply with any requirement of this provision or CRS 8-17.5-101 et seq., the State may terminate this contract for breach and the Contractor shall be liable for actual and consequential damages to the State.

   A Contractor that operates as a sole proprietor hereby swears or affirms under penalty of perjury that the Contractor (i) is a citizen of the United States or otherwise lawfully present in the United States pursuant to federal law, (ii) shall comply with the provisions of CRS 24-76.5-101 et seq, and (iii) shall produce one of the forms of identification required by CRS 24-76.5-103 prior to the effective date of this Contract. Except where exempted by federal law and except as provided in CRS 24-76.5-103(3), a Contractor that receives federal or state funds under this contract must confirm that any individual natural person eighteen years of age or older is lawfully present in the United States pursuant to CRS 24-76.5-103(4) if such individual applies for public benefits provided under this contract.

5. **TAXES:** The bidder's attention is called to the fact that the Bid submitted shall exclude all applicable federal excise or manufacturers' taxes and all state sales and use taxes as hereinafter set forth in Article 9C of the GENERAL CONDITIONS.

6. **OR EQUAL:** The words "OR EQUAL" are applicable to all specifications and drawings relating to materials or equipment specified. Any material or equipment that will fully perform the duties specified, will be considered "equal", provided the bid submits proof that such material or equipment is of equivalent substance and function and is approved, in writing. Requests for the approval of "or equal" shall be made in writing at least five (5) business days prior to bid opening. During the bidding period, all approvals shall be issued by the Architect/Engineer in the form of addenda at least two (2) business days prior to the bid opening date.

7. **ADDENDA**: Owner/architect initiated addenda shall not be issued later than two (2) business days prior to bid opening date. All addenda shall become part of the Contract Documents and receipt must be acknowledged on the Bid form.

8. **METHOD OF AWARD - LOWEST RESPONSIBLE BIDDER:** If the bidding documents for this project require alternate prices, additive and/or deductible alternates shall be listed on the alternates bid form provided by the Principal Representative. Bidders should note the Method of Award is applicable to this Bid as stated below.

   A. **DEDUCTIBLE ALTERNATES:** The lowest responsible Bid, taking into account the Colorado resident bidder preference provision of Colorado law, will be determined by and the contract will be awarded on the base bid combined with deductible alternates, deducted in numerical order in which they are listed in the alternates bid form provided by the Principal Representative. The subtraction of alternates shall result in a sum total within available funds. If this bid exceeds such amount, the right is reserved to reject all bids. An equal number of alternates shall be subtracted from the base bid of each bidder within funds available for purposes of determining the lowest responsible bidder.

   B. **ADDITIVE ALTERNATES:** The lowest responsible Bid, taking into account the Colorado resident bidder preference provision of Colorado law, will be determined by and the contract will be awarded on the base bid plus all additive alternates added in the numerical order in which they are listed in the alternates bid form provided by the Principal Representative. The addition of alternates shall result in a sum total within available funds. If this bid exceeds such amount, the right is reserved to reject all bids. An equal number of alternates shall be added to the base bid of each bidder within funds available for purposes of determining the lowest responsible bidder.

   C. **DEDUCTIBLE AND ADDITIVE ALTERNATES:** Additive alternates will not be used if deductible alternates are used and deductible alternates will not be used if additive alternates are used.

9. **NOTICE OF CONTRACTOR'S SETTLEMENT** – Agencies/institutions must indicate in the initial Solicitation (Advertisement for Bids, Documented Quotes, or Requests for Proposals) whether settlement will be advertised in newspapers or electronic media.

The Advertisement for Bids can be located at the web site: /www.colorado.gov/pacific/osa/cdnotices
(Click on the appropriate link [ColoradoVSS or ColoradoBIDS] or on the State Purchasing Office website)

SECTION 00 41 53 – BID FORM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. 00 43 13 - Bid Bond (SPB-6.14)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 BID FORM

A. FORM: State of Colorado form “Bid” (SBP-6.13).

B. A copy of the above noted form is attached to the end of this section.

C. Additional State and University of Colorado forms to be attached to the submitted bid are listed in the Articles below.

1.5 PROCEDURES

A. The durations for Bidder’s Time of Completion shall match the project advertisement duration.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 41 53

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAMS

BID

Institution/Agency: Unibersity of Colorado Anschutz Medical Campus

Project No./Name: 23-110899 / Perinatal Research Facility – Power, HVAC, Boiler Upgrades

Bidder Acknowledges Receipt of Addenda Numbers:	
Bidder Anticipates Services outside the United States or Colorado:*	No ☐ Yes ☐ If Yes see 3A below
Bidder will comply with 80% Colorado Labor on project above $500,000:	Yes☐ No ☐ If No see 3B below
Bidder is a Service-Disabled Veteran Owned Small Business:*	No ☐ Yes ☐ If Yes see 3C below

Base Bid $

(Refer to Bid Alternate Form SC-6.13.1 Attached, If Applicable)

Bidder's Time of Completion

a. Substantial Completion Date:	9/30/2024
b. Final Acceptance Date:	10/31/2024
c. Total Time of Completion of Entire Project:	*12/18/2023 – 10/31/2024
• On site Construction from	7/08/2024 – 9/30/2024

1. **BID:** Pursuant to the advertisement by the State of Colorado dated 10/30/23 the undersigned bidder hereby proposes to furnish all the labor and materials and to perform all the work required for the complete and prompt execution of everything described or shown in or reasonably implied from the Bidding Documents, including the Drawings and Specifications, for the work and for the base bid indicated above. Bidders should include all taxes that are applicable.
2. **EXAMINATION OF DOCUMENTS AND SITE:** The bidder has carefully examined the Bidding Documents, including the Drawings and Specifications, and has examined the site of the Work, so as to make certain of the conditions at the site and to gain a clear understanding of the work to be done.
3. **PARTIES INTERESTED IN BID:** The bidder hereby certifies that the only persons or parties interested in this Bid are those named herein, and that no other bidder or prospective bidder has given any information concerning this Bid.
   - **A.** If the bidder anticipates services under the contract or any subcontracts will be performed outside the United States or Colorado, the bidder shall provide in a written statement which must include, but need not be limited to the type of services that will be performed at a location outside the United States or Colorado and the reason why it is necessary or advantageous to go outside the United States or Colorado to perform such services. (Does not apply to any project that receives federal moneys) *
   - **B.** For State Public Works projects per C.R.S. 8-17-101, Colorado labor shall be employed to perform at least 80% of the work. Colorado Labor means any person who is a resident of the state of Colorado at the time of the Public Works project. Bidders indicating that their bid proposal will not comply with the 80% Colorado Labor requirement are required to submit written justification along with the bid submission. (Does not apply to any project that receives federal moneys) *
   - **C.** A Service-Disabled Veteran Owned Small Business (SDVOSB) per C.R.S. 24-103-211, means a business that is incorporated or organized in Colorado or maintains a place of business or has an office in Colorado and is officially registered and verified by the Center for Veteran Enterprise within the U.S. Department of Veteran Affairs. Attach proof of certification along with the bid submission. *
4. **BID GUARANTEE:** This Bid is accompanied by the required Bid Guarantee. You are authorized to hold said Bid Guarantee for a period of not more than thirty (30) days after the opening of the Bids for the work above indicated, unless the undersigned bidder is awarded the Contract, within said period, in which event the Director, State Buildings Programs, may retain said Bid Guarantee, until the undersigned bidder has executed the required Agreement and furnished the required Performance Bond, Labor and Material Payment Bond, Insurance Policy and Certificates of Insurance and Affidavit Regarding Unauthorized Immigrants.
5. **TIME OF COMPLETION: The bidder agrees to achieve the stated Substantial Completion date of the Project as noted above**. If awarded the Work, the bidder agrees to begin performance within ten (10) days from the date of the

Notice to Proceed subject to Article 46, Time of Completion and Liquidated Damages of the General Conditions of the Contract, and agrees to prosecute the Work with due diligence to completion. The bidder represents that Article 7D of the Contractor's Agreement (SC-6.21) has been reviewed to determine the type and amount of any liquidated damages that may be specified for this contract.

6. **EXECUTION OF DOCUMENTS:** The bidder understands that if this Bid is accepted, bidder must execute the required Agreement and furnish the required Performance Bond, Labor and Material Payment Bond, Insurance Policy and Certificates of Insurance and Affidavit Regarding Unauthorized Immigrants within ten (10) days from the date of the Notice of Award, and that the bidder will be required to sign to acknowledge and accept the Contract Documents, including the Drawings and Specifications.
7. **ALTERNATES:** Refer to the Information for Bidders (SC-6.12) for Method of Award for Alternates and use State Form SBP-6.13.1 Bid Alternates form to be submitted with this bid form if alternates are requested by the institution/agency in the solicitation documents.
8. **Submit wage rates** (direct labor costs) for prime contractor and subcontractor as requested by the institution/agency in the solicitation documents.
9. **The right is reserved to waive informalities and to reject any and all Bids.**

**Does not apply to projects for Institutions of Higher Education that have opted out of the State Procurement Code.*

SIGNATURES: If the Bid is being submitted by a Corporation, the Bid shall be signed by an officer, i.e., President or Vice-President. If a sole proprietorship or a partnership is submitting the Bid, the Bid shall so indicate and be properly signed.

Dated this _____ Day of _____ , 20_____

THE BIDDER:

Company Name	Address (including city, state and zip)
Phone number:	
Name (Print) and Title	Signature

SECTION 00 41 55 – DIRECT LABOR BURDEN CALCULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 DIRECT LABOR BURDEN CALCULATION

A. FORM: State of Colorado form “Direct Labor Burden Calculation” (SBP-6.18).

B. A copy of the above noted form is attached to the end of this section.

C. Additional State and University of Colorado forms to be attached to the submitted bid are listed in the Articles below.

1.5 PROCEDURES

A. The form shall be submitted for the bidding firm on award of low bid and prior to contract being issued.

B. Submission of a project bid acknowledges agreement of this requirement. Fail to submit this form may deem a bid as non-responsive

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 41 55

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

DIRECT LABOR BURDEN CALCULATION

Institution/Agency: University of Colorado Anschutz Medical Campus
Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

This form is required to be submitted for review prior to execution of a construction agreement.

List items below by the percentage of what makes up the total labor burden; Items include benefits that a contractor pays to employees on their payroll. Examples include taxes, pension cost, health and dental insurance etc. The Labor Burden amount must be agreed to by both the contractor and Principal Representative and will be included in the contract as part of Exhibit A and will be used in the calculation of any future Change Order Proposals (SC-6.312) Line 2.

Major sub-contractors defined as electricians, plumbers, mechanical contractors, excavators, millwork, concrete, block layers etc. Please provide one (1) Labor Burden Calculation Sheet per contractor and for each sub-contractor. These labor burdens shall be used in the calculation of any future Change Order Proposals (SC-6.312) Line 10.

State reserves the right to require back-up confirmation of all information included in this calculation.

	Percent of Salary Paid	
Payroll Taxes		
Pension Costs		
Health Insurance		
Dental Insurance		
Life Insurance		
Other (Specify)		Description: _____
Other (Specify)		Description: _____
Total Labor Burden:	0%	

SECTION 00 43 13 – BID BOND

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 BID BOND

A. FORM: State of Colorado form “Bid Bond” (SBP-6.14).

B. A copy of the above noted form is attached to the end of this section.

1.2 PROCEDURES

A. This bid bond must be accompanied by Power of Attorney.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 43 13

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

BID BOND

Institution/Agency: University of Colorado Anschutz Medical Campus
Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

KNOW ALL MEN BY THESE PRESENTS:

WHEREAS, _____ hereinafter called the "PRINCIPAL", is submitting a PROPOSAL for the above described project, to the STATE OF COLORADO, hereinafter called the "OBLIGEE".

WHEREAS, the Advertisement for Bids has required as a condition of receiving the Proposals that the Principal submit with the PROPOSAL GUARANTY in an amount not less than five per cent (5%) of the Proposal, which sum it is specifically agreed is to be forfeited as Liquidated Damages in the event that the Principal defaults in his obligation as hereinafter specified, and, in pursuance of which Requirement, this Bid is made, executed and delivered.

NOW THEREFORE, the Principal and _____ a corporation of the State of _____, duly authorized to transact business in Colorado, as Surety, are held and firmly bound unto the Obligee, in the sum of five per cent (5%) of the Principal's total bid price, lawful money of the United States for the payment of which sum, well and truly to be made to the Obligee, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

FURTHER THAT, a condition of the obligation that the Principal shall maintain his Proposal in full force and effect for thirty (30) days after the opening of the proposals for the project, or, if the Principal's Proposal is accepted, the Principal shall, within the prescribed time, execute the required Agreement, furnish the required Performance Bond, Labor and Material Payment Bond, Insurance Policy, Certificates of Insurance and Certification and Affidavit Regarding Illegal Aliens, then this obligation shall be null and void, otherwise it shall remain in full force and effect, and subject to forfeiture upon demand as Liquidated Damages.

IN WITNESS WHEREOF said Principal and Surety have executed this Bond, this _____ day of _____, A.D., 20_____.

(Corporate Seal)

ATTEST

_____
Secretary

_____
Name (Print)

THE PRINCIPAL

_____
Company Name

_____
Address (including city, state and zip)
Phone number: _____

_____
Signature

_____
Name (Print) and Title

SIGNATURES If the "Principal" is doing business as a Corporation, the Bid Bond shall be signed by an officer, i.e., President or Vice President. The signature of the officer shall be attested to by the Secretary and properly sealed.

If the "Principal" is an individual or a partnership, the Bid Bond shall so indicate and be properly signed.

(Corporate Seal)

_____
Secretary

THE SURETY

_____

By _____
Attorney-in-Fact

THIS BOND MUST BE ACCOMPANIED BY POWER OF ATTORNEY, EFFECTIVELY DATED.
FAILURE TO PROVIDE A PROPERLY EXECUTED BID BOND WITH A PROPERLY EXECUTED POWER OF ATTORNEY WILL RESULT IN THE BIDDER'S PROPOSAL BEING DEEMED NON-RESPONSIVE.

SECTION 00 43 40 -

CERTIFICATE AND AFFIDAVIT REGARDING UNAUTHORIZED IMMIGRANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. The form UI-1 shall be provided by all contractors, architect, engineers and consultants directly engaged with the University of Colorado Denver | Anschutz Medical Campus.

1.3 DEFINITIONS (Not Applicable)

1.4 CERTIFICATE AND AFFIDAVIT REGARDING UNAUTHROIZED IMMIGRANTS

A. FORM: State of Colorado form “CERTIFICATE AND AFFIDAVIT REGARDING UNAUTHORIZED IMMIGRANTS” (UI-1).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 43 40

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAMS

CERTIFICATION AND AFFIDAVIT REGARDING UNAUTHORIZED IMMIGRANTS

Institution/Agency: University of Colorado Anschutz Medical Campus
Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

A. CERTIFICATION STATEMENT CRS 8-17.5-101 & 102 (HB 06-1343, SB 08-193)

The Vendor, whose name and signature appear below, certifies and agrees as follows:

1. The Vendor shall comply with the provisions of CRS 8-17.5-101 et seq. The Vendor shall not knowingly employ or contract with an unauthorized immigrant to perform work for the State or enter into a contract with a subcontractor that knowingly employs or contracts with an unauthorized immigrant.

2. The Vendor certifies that it does not now knowing employ or contract with and unauthorized immigrant who will perform work under this contract, and that it will participate in either (i) the "E-Verify Program", jointly administered by the United States Department of Homeland Security and the Social Security Administration, or (ii) the "Department Program" administered by the Colorado Department of Labor and Employment in order to confirm the employment eligibility of all employees who are newly hired to perform work under this contract.

3. The Vendor shall comply with all reasonable requests made in the course of an investigation under CRS 8-17.5-102 by the Colorado Department of Labor and Employment. If the Vendor fails to comply with any requirement of this provision or CRS 8-17.5-101 et seq., the State may terminate work for breach and the Vendor shall be liable for damages to the State.

B. AFFIDAVIT CRS 24-76.5-101 (HB 06S-1023)

1. If the Vendor is a **sole proprietor**, the undersigned hereby swears or affirms under penalty of perjury under the laws of the State of Colorado that (check one):

[___] I am a United States citizen, or

[___] I am a Permanent Resident of the United States, or

[___] I am lawfully present in the United States pursuant to Federal law.

I understand that this sworn statement is required by law because I am a sole proprietor entering into a contract to perform work for the State of Colorado. I understand that state law requires me to provide proof that I am lawfully present in the United States prior to starting work for the State. I further acknowledge that I will comply with the requirements of CRS 24-76.5-101 et seq. and will produce the required form of identification prior to starting work. I acknowledge that making a false, fictitious, or fraudulent statement or representation in this sworn affidavit is punishable under the criminal laws of Colorado as perjury in the second degree under CRS 18-8-503 and it shall constitute a separate criminal offense each time a public benefit is fraudulently received.

CERTIFIED and AGREED to this day _____.

VENDOR:

_____
Vendor Full Legal Name

BY: _____ _____
Signature of Authorized Representative Title

SECTION 00 45 17 – SUBCONTRACTOR PREQUALIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 SUBCONTRACTOR PREQUALIFICATION

A. FORM: University of Colorado Denver | Anschutz Medical Campus "Subcontractor's Statement of Experience."

B. A copy of the above noted document is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 45 17

University of Colorado
Denver | Anschutz Medical Campus

Facilities Management

SUBCONTRACTOR'S STATEMENT OF EXPERIENCE

Project Name: PRF- Power, HVAC, Boiler Upgrades

Project # 23-110899

Project Manager: Robert Holzwarth
Phone: (720)854-4664
Email: robert.holzwarth@cuanschutz.edu

Architect/Engineer: Aaron Sheburne - MEP

- **This is a project specific qualification form. Subcontractor must fill this out on each project.**

INDEX OF DOCUMENTS

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

INFORMATION FORM

STATEMENT OF _____
(Subcontractor)

ADDRESS _____
(Street or PO Box) (City) (State) (Zip)

TELEPHONE/FAX NO. _____ _____
(telephone) (fax)

DATE OF EXPERIENCE STATEMENT _____

PRINCIPLE OWNER/OFFICER _____
(Names(s) and Official Title(s))

Please indicate below if your company qualifies as one of the following:

Minority Business Enterprise (MBE) YES __ NO ___

Justification: _____

_____

_____

Woman-Owned Business Enterprise (WBE)YES ___ NO ___

Justification: _____

_____

_____

Small Business Enterprise (SBE) YES __ NO ___

Justification: _____

_____

_____

Disadvantaged Business Enterprise (DBE) YES __ NO ___

Justification: _____

_____

_____

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

TYPES OF WORK

(1) If you are a General Contractor interested in bidding on all types of construction, mark "All Classes of Construction" only.
(2) If you are interested in contracting directly with the University for certain types of work only, mark in the column provided after the particular types of work on which you wish to bid.

TYPES OF WORK	MARK WITH (X)
1. All Classes of Construction	
2. General	
3. Mechanical	
4. Electrical	
5. Excavating and Grading	
6. Concrete	
7. Structural Steel	
8. Steel and Miscellaneous Iron	
9. Painting and Decorating	
10. Laboratory Equipment	
11. Elevator Installation	
12. Plumbing	
13. Heating and Ventilating	
14. Air Conditioning	
15. Boiler and Equipment	
16. Environmental (Describe)	
17. Other (Describe)	
18. Other (Describe)	
19. Other (Describe)	
20. Other (Describe)	

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

IDENTIFICATION

(The signatory of this questionnaire guarantees the truth and accuracy of all statements and of all answers to questions hereinafter made.)

LEGAL NAME _____

PRINCIPAL OFFICE _____
(Street or PO Box) (City) (State) (Zip)

_____ A Corporation ___A Copartnership ___An Individual __Combination

GENERAL INFORMATION

A. Are you licensed as a contractor? Yes ( ) No ( )

Licensed in the name of	Location (City or State)	License No. & Type

B. How many years has your organization been in business as a contractor under your present business name?_____

C. How many years experience in _____ construction work has your organization had? (Type)

(a) As a prime contractor? _____ (b) As a subcontractor?

D. Have you or your organization, or any officer or partner thereof, failed to complete a contract? _____

If so, give details _____

E. If you have a controlling interest in any firms presently qualified with the University, show names thereof:

F. We normally perform ___% of the work with our own forces.

List trades: _____

Where qualification is based on a combination of several organizations, show the experience and equipment of the combined organizations.

G. Has your firm been involved in any litigation in the past five (5) years? Yes ( ) No ( )
If yes, explain (listing type, kind, plaintiff, defendant, etc. and state the current status).

H. Are there any activities or interests of officers, principle stockholders, or employees of your firm or other factors which would place your firm and the University of Colorado Denver in a position of “Conflict of Interests”?

Yes ( ) No ( ) If yes, or in doubt, explain.

I. Has your firm ever been involved in any bankruptcy action as a bankrupt?

Yes ( ) No ( ) If yes, explain.

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

PERSONNEL OF ORGANIZATION

1. Name the persons with whom you have been associated in business as partners or business associates in each of the last five (5) years.

   _____
   _____
   _____
   _____
   _____
   _____

2. Show the construction experience of the principal individuals of your present organization in the following tabulation:

Individual's Name	Present Position or Office in Your Organization	Years of Construction Experience	Magnitudes and Type of Work	In What Capacity

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

PROJECT EXPERIENCE

Show the projects your organization has completed during the last five years in the following tabulation:

Year Completed	Project	Type of Work (See Page 2)	Location	Contract Value	Contracting Authority	In what Capacity

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

WORK CURRENTLY UNDER CONTRACT

Expected Completion Date	Project	Type of Work (See Page 1)	Location	Contract Value	Contracting Authority	Architector Engineer

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

SURETIES

List the Surety Companies that have bonded your work for the past five (5) years:

Name of Surety and Name and Address of Agent	Project and Location	Period of Bond From	Period of Bond To	General Comments

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

CORPORATION / CO-PARTNERSHIP

CORPORATION:
(If a corporation, answer this:)

When Incorporated _____

In What State _____

President's Name _____

Vice President's Name _____

Secretary's Name _____

Treasurer's Name _____

CO-PARTNERSHIP:
(If a co-partnership, answer this:)

Date of Organization _____

State whether partnership is general, limited, or association

_____

Name and address of each partner:

_____	_____
(name)	(name)
_____	_____
(address)	(address)
_____	_____
_____	_____

WHERE QUALIFICATION IS BASED ON A COMBINATION OF ORGANIZATIONS, THE APPROPRIATE (ATTACHED) AFFIDAVITS MUST BE EXECUTED FOR EACH MEMBER OF SUCH COMBINATION.

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

AFFIDAVIT FOR CORPORATION

_____ certifies and says: That he is
(Name of officer)

_____ of the _____ (Official capacity)

corporation submitting this statement of experience: that he/she has read the same, and that the same is true of his/her own knowledge: that the statement is for the purpose of inducing the University of Colorado Denver to supply the submittor with plans and specifications, and that any vendor, or other agency therein named is hereby authorized to supply the University of Colorado Denver with any information necessary to verify the statement: and that furthermore, should this statement at any time cease to properly and truly represent his/her condition in any substantial respect, it will refrain from further bidding on University work until it shall have submitted a revised and corrected statement.

I certify and declare under penalty of perjury that the foregoing is true and correct:

Subscribed on _____ at ___, _____, State of _____
(date) (city) (county)

NOTE: Use full corporate name and
attach corporate seal here. _____
(Officer must sign here)

NOTE: Statement will be returned unless affidavit is completed in EVERY respect.

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

AFFIDAVIT FOR CO-PARTNERSHIP

_____ certifies and says: That he/she is a partner of
(Name of partner)

the partnership of _____: That said partnership
(Name of Firm)

submitted this statement of experience: that he/she has read the same, and that the same is true of his/her own knowledge: that the statement is for the purpose of inducing the University of Colorado Denver to supply the submittor with plans and specifications, and that any vendor, or other agency therein named is hereby authorized to supply the University of Colorado Denver with any information necessary to verify the statement: and that furthermore, should this statement at any time cease to properly and truly represent the condition of said firm in any substantial respect, it will refrain from further bidding on University work until they shall have submitted a revised and corrected statement.

I certify and declare under penalty of perjury that the foregoing is true and correct:

Subscribed on _____ at ____, _____, State of _____
(date) (city) (county)

The foregoing statement and affidavit are hereby offered.

_____ _____
(Member of Firm must sign here)

_____ _____
(Title)

_____ _____
(Remaining members of Firm sign here) (Name of Firm)

NOTE: Statement will be returned unless affidavit is completed in EVERY respect.

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

AFFIDAVIT FOR INDIVIDUAL

_____ doing business _____
(Name of individual) (Name of Firm)

certifies and says: That he/she is the person submitting this statement of experience: that he/she has read the same, and that the same is true of his/her own knowledge: that the statement is for the purpose of inducing the University of Colorado Denver to supply the submittor with plans and specifications, and that any vendor, or other agency therein named is hereby authorized to supply the University of Colorado Denver with any information necessary to verify the statement: and that furthermore, should this statement at any time cease to properly and truly represent his/her condition in any substantial respect, it will refrain from further bidding on University work until it shall have submitted a revised and corrected statement.

I certify and declare under penalty of perjury that the foregoing is true and correct:

Subscribed on _____ at ___, _____, State of _____
(date) (city) (county)

NOTE: Statement will be returned unless
affidavit is completed in EVERY respect. _____
(Applicant must sign here)

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUBCONTRACTOR'S QUALIFICATION STATEMENT

BIDDING INFORMATION

QUALIFICATION

The University of Colorado Denver will qualify or disqualify a Subcontractor on the basis of:

(1) The information contained in this statement and
(2) Past contract experience with the University.

NOTIFICATION

The University of Colorado Denver will, in writing, notify Contractors of their qualification or disqualification.

SECTION 00 51 00 – NOTICE OF AWARD (D/B/B)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 NOTICE OF AWARD

A. FORM: State of Colorado form “Notice of Award” (SBP-6.15) for Design/Bid/Build Agreements.

B. Copies of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 51 00

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAMS

NOTICE OF AWARD

(Design/Bid/Build and Design/Build Lump Sum Agreements)

Date of Notice: _____
Date to be inserted by the Agency/Institution

Agency/Institution: University of Colorado Anschutz Medical Campus

Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

TO:

The State of Colorado, represented by the undersigned, has considered the Proposals submitted for the above described work.

Your Proposal, deemed to be in the best interest of the State of Colorado, in the amount of _____ DOLLARS AND NO/100* ($_____*) is hereby accepted, pending final execution of the Agreement.

You **are** required to execute the approved Agreement and to furnish the Performance Bond, Labor and Material Payment Bond, Insurance Policy and Certificates of Insurance, Certification and Affidavit Regarding Unauthorized Immigrants and Labor Overhead (Direct Labor Burdens) for Work performed by Contractor and major Subcontractors within ten (10) days from the date of this Notice.

If you fail to execute said Agreement and to furnish said Performance Bond, Labor and Material Payment Bond, Insurance Policy, Certificates of Insurance, Certification and Affidavit Regarding Unauthorized Immigrants, and Labor Overhead (Direct Labor Burdens) as described above within ten (10) days from the date of this Notice, the State Controller is entitled to retain the amount of the Proposal Guaranty submitted with your Proposal as Liquidated Damages. In this event, the right is reserved to consider all of your rights arising out of the acceptance of your Proposal as abandoned and to award the work covered by your Proposal to another, or to re-advertise the Project, or otherwise dispose thereof.

By _____
State Buildings Programs (or Authorized Delegate) Date

By _____
Principal Representative (Agency/Institution) Date

When completely executed, this form is to be sent by **certified mail** to the Contractor by the Principal Representative or delivered by any other means to which the parties agree.

SECTION 00 52 53.05 – CONTRACTOR'S DESIGN/BID/BUILD (D/B/B) AGREEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. A sample copy of the above noted form is attached to the end of this section.

1.3 DEFINITIONS (Not Applicable)

1.4 CONTRACOR'S DESIGN/BID/BUILD (D/B/B) AGREEMENT

A. FORM: State of Colorado form "Contractor's Design/Bid/Build (D/B/B) Agreement" (SC-6.21).

B. A copy of the above noted document is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 52 53.05

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD (D/B/B) AGREEMENT

(STATE FORM SC-6.21)

DEPARTMENT ID: _____

CONTRACT ID #: _____

PROJECT #: _____

PROJECT NAME: _____

VENDOR NAME: _____

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.21)

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E. Certification and Affidavit Regarding Unauthorized Immigrants (State Form UI - 1), (required at contract signing prior to commencing work)
F. Building Code Compliance Policy: Coordination of Approved Building Codes, Plan Reviews and Building Inspections.

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD (D/B/B) AGREEMENT
(STATE FORM SC-6.21)

Department ID: _____ Contract ID #: _____ Project #: _____

1. PARTIES. THIS AGREEMENT is entered into by and between the STATE OF COLORADO, acting by and through the *(agency)*, hereinafter referred to as the Principal Representative, and *(vendor name)* having its offices at *(vendor address)* hereinafter referred to as the Contractor.

2. EFFECTIVE DATE AND NOTICE OF NONLIABILITY. This Agreement shall not be effective or enforceable until it is approved and signed by the State Controller or its designee (hereinafter called the "Effective Date"), but shall be effective and enforceable thereafter in accordance with its provisions. The State shall not be liable to pay or reimburse Contractor for any performance hereunder or be bound by any provision hereof prior to the Effective Date.

RECITALS:

WHEREAS, the Principal Representative intends to procure *(project name)* hereinafter called the Project; and

WHEREAS, authority exists in the Law and Funds have been budgeted, appropriated, and otherwise made available, and a sufficient unencumbered balance thereof remains available for payment In Fund Number _____, Account Number _____; and

WHEREAS, this is a phase one waived contract, waiver number 156 Contractors Agreement for Capital Construction Form SC6.21.

WITNESSETH, that the State of Colorado and the Contractor agree as follows:

ARTICLE 1. PERFORMANCE OF THE WORK
The Contractor shall perform all of the Work required for the complete and prompt execution of everything described or shown in, or reasonably implied from the Contract Documents for the above referenced Project.

ARTICLE 2. PROVISIONS OF THE CONTRACT DOCUMENTS
The Contractor agrees to perform the Work to the highest industry standards and to the satisfaction of the State of Colorado and its Architect/Engineer in strict accordance with the provisions of the Contract Documents.

ARTICLE 3. TIME OF COMPLETION
The Contractor agrees to Substantially Complete the Project within _____ calendar days from the date of the Notice to Proceed, in addition, the Contractor agrees to finally complete the Project from Substantial Completion to Final Acceptance within ____ calendar days for a total time of completion of the entire Project of ____ calendar days. The Contractor shall perform the Work with due diligence to completion.

ARTICLE 4. ESSENTIAL CONDITION
Timely completion of the Project is an essential condition of this Agreement. The Contractor shall be subject to any liquidated damages described in Article 7.4 for failure to satisfactorily complete the Work within the time periods in Article 3 above.

ARTICLE 5. CONTRACT SUM

The Contractor shall be paid for the performance of this Agreement, subject to any additions and deductions as provided for in Articles 32, 34 and 35 of The General Conditions of the Construction Contract SC-6.23, the sum of _____ DOLLARS AND NO/100* ($_____*).

ARTICLE 6. CONTRACT DOCUMENTS

The Contract Documents, as enumerated in Article 1 of The General Conditions of the Contractor's Design/Bid/Build (D/B/B) Agreement SC-6.23, are all essential parts of this Agreement and are fully incorporated herein.

ARTICLE 7. OPTIONAL PROVISIONS AND ELECTIONS

The provisions of this Article 7 alter the Articles (The General Conditions of the Contractor's Design/Bid/Build Agreement SC-6.23) or enlarge upon them as indicated:
The Principal Representative and or the State Buildings Program shall mark boxes and initial where applicable.

1. MODIFICATION OF ARTICLE 45. GUARANTEE INSPECTIONS AFTER COMPLETION

If the box below is marked the six month guarantee inspection is not required.
☐ _____ Principal Representative initial

2. MODIFICATION OF ARTICLE 27. LABOR AND WAGES

If the box is marked the Federal Davis-Bacon Act shall be applicable to the Project. The minimum wage rates to be paid on the Project shall be furnished by the Principal Representative and included in the Contract Documents.
☐ _____ Principal Representative initial

3. MODIFICATION OF ARTICLE 39. NON-BINDING DISPUTE RESOLUTION – FACILITATED NEGOTIATIONS

If the box is marked, and initialed by the State as noted, the requirement to participate in facilitated negotiations shall be deleted from this Contract. Article 39, Non-Binding Dispute Resolution – Facilitated Negotiations, shall be deleted in its entirety and all references to the right to the same where ever they appear in the contract shall be similarly deleted.
The box may be marked only for projects with an estimated value of less than $500,000.
☐ _____ Principal Representative initial

4. MODIFICATION OF ARTICLE 46. TIME OF COMPLETION AND LIQUIDATED DAMAGES

If an amount is indicated immediately below, liquidated damages shall be applicable to this Project as, and to, the extent shown below. Where an amount is indicated below, liquidated damages shall be assessed in accordance with and pursuant to the terms of The General Conditions of the Design/Bid/Build Agreement Article 46, Time of Completion And Liquidated Damages, in the amounts and as here indicated. The election of liquidated damages shall limit and control the parties right to damages only to the extent noted.

4.1. For the inability to use the Project, for each day after the number of calendar days specified in the Contractor's bid for the Project and the Agreement for achievement of Substantial Completion, until the day that the Project has achieved Substantial Completion and the Notice of Substantial Completion is issued, the Contractor agrees that an amount equal to _____
($) shall be assessed against Contractor from amounts due and payable to the Contractor under the Contract, or the Contractor and the Contractor's Surety shall pay to the Principal Representative such sum for any deficiency, if amounts on account thereof are deducted from remaining amounts due, but amounts remaining are insufficient to cover the entire assessment.

4.2. For damages related to or arising from additional administrative, technical, supervisory and professional expenses related to and arising from the extended closeout period, for each day in excess of the number of calendar days specified in the Contractor's bid for the Project and the Agreement to finally complete the Project as defined by the issuance of the Notice of Final Acceptance) after the issuance of the final Notice of Substantial Completion, the Contractor agrees that an amount equal to _____ ($) shall be assessed against Contractor from amounts due and payable to the Contractor under the Contract, or the Contractor and the Contractor's Surety shall pay to the Principal Representative such sum for any deficiency, if amounts on account thereof are deducted from remaining amounts due but amounts remaining are insufficient to cover the entire assessment.

ARTICLE 8. NOTICE IDENTIFICATION

All Notices pertaining to General Conditions or otherwise required to be given shall be transmitted in writing, to the individuals at the addresses listed below, and shall be deemed duly given when received by the parties at their addresses below or any subsequent persons or addresses provided to the other party in writing.

Notice to Principal Representative:

With copies to (State Buildings Program (or Delegate) State of Colorado):

Notice to Contractor:

With copies to:

SIGNATURE APPROVALS:

THE PARTIES HERETO HAVE EXECUTED THIS CONTRACT

*Persons signing for Contractor hereby swear and affirm that they are authorized to act on Contractor's behalf and acknowledge that the State is relying on their representations to that effect. **Principal is not a recognized title and will not be accepted**

THE CONTRACTOR

Legal Name of Contracting Entity

*Signature

By _____
Name (print) Title

Date: _____

STATE OF COLORADO, acting by and through:
(Insert Name of Agency or IHE)

By: _____
(Insert Name & Title of Principal Representative for Agency or IHE)

Date: _____

APPROVED
DEPARTMENT OF PERSONNEL & ADMINISTRATION
STATE BUILDINGS PROGRAM
State Architect (or authorized Delegate)

By: _____
(Insert Name of Authorized Individual)

Date: _____

ALL CONTRACTS MUST BE APPROVED BY THE STATE CONTROLLER:

C.R.S. § 24-30-202 requires the State Controller to approve all State Contracts. This Contract is not valid until signed and dated below by the State Controller or delegate. Contractor is not authorized to begin performance until such time. If Contractor begins performing prior thereto, the State of Colorado is not obligated to pay Contactor for such performance or for any goods and/or services provided hereunder.

APPROVED:
STATE OF COLORADO
STATE CONTROLLER'S OFFICE
State Controller (or authorized Delegate)

By: _____
(Insert Name & Title of Authorized Individual)

Date: _____

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.21)

EXHIBIT A

CONTRACTOR'S BID (Form SBP-6.13)

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.21)

EXHIBIT B

PERFORMANCE BOND (Form SC-6.22)

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.21)

EXHIBIT C

LABOR AND MATERIAL PAYMENT BOND (Form SC-6.221)

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.21)

EXHIBIT D

INSURANCE CERTIFICATE(S) (attached)

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.21)

EXHIBIT E

Certification and Affidavit Regarding Unauthorized Immigrants (State Form UI-1), (required at contract signing prior to commencing work)

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.21)

EXHIBIT F

Building Code Compliance Policy: Coordination of Approved Building Codes, Plan Reviews and Building Inspections

SECTION 00 55 00 – NOTICE TO PROCEED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 NOTICE TO PROCEED

A. FORM: State of Colorado form “Notice To Proceed (Design/Bid/Build Contract)” (SBP-6.26).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 55 00

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

NOTICE TO PROCEED (DESIGN/BID/BUILD CONTRACT)

Date of Notice: _____
Date to be inserted by the Principal Representative

Date/Description of Contract Documents: _____

Institution/Agency: University of Colorado Anschutz Medical Campus

Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

Attach Notice of Code Compliance from Code Review Agent/Building Official for Documents Listed Above

To:

This is to advise you that your Performance Bond, Labor and Material Payment Bond, Insurance Policy and Certificates of Insurance, and Affidavit Regarding Unauthorized Immigrants have been received. Our issuance of this Notice does not relieve you of responsibility to assure that the bond and insurance requirements of the Contract Documents are met for the duration of the Agreement. The Agreement dated _____ covering the above described work has been fully executed.

You are hereby authorized and directed to proceed within ten (10) days from date of this Notice as required in the Agreement. Any liquidated damages for failure to achieve Substantial Completion by the date agreed that may be applicable to this Contract will be calculated using the date of this Notice for the date of the commencement of the Work.

The completion date of the Project is _____ (M/D/YYYY).

By _____ Date
State Buildings Program
(or Authorized Delegate)

By _____ Date
Principal Representative
(Institution or Agency)

When completely executed, this form is to be sent by certified mail to the Contractor by the Principal Representative; or delivered by any other means to which the parties agree.

SECTION 00 61 13.13 – PERFORMANCE BOND

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 PERFORMANCE BOND

A. FORM: State of Colorado form “Performance Bond” (SC-6.22).

B. A copy of the above noted form is attached to the end of this section.

1.2 PROCEDURE

A. Performance Bond is required for construction values of $150,000 or more.

B. This bond must be accompanied by Power of Attorney.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 61 13.13

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

PERFORMANCE BOND

Institution/Agency: University of Colorado Anschutz Medical Campus
Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

BONDING COMPANY: DO NOT MAKE ANY CHANGES TO THE LANGUAGE IN THIS BOND.

KNOW ALL PERSONS BY THESE PRESENTS:

That the Contractor

as Principal and hereinafter called "Principal,"

and

as Surety and hereinafter called "Surety," a corporation organized and existing under the laws of _____ are held and firmly bound unto **the STATE OF COLORADO** acting by and through Board of Regents of the University of Colorado, a body corporate, for and on behalf of the University of Colorado Denver, hereinafter called the "Principal Representative", in the sum of _____ _____ Dollars ($_____)

for the payment whereof the Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly, by these presents.

WHEREAS, the Principal and the State of Colorado acting by and through the Principal Representative have entered into a certain Contract, hereinafter called "Contract," dated _____ _____, 20___, for the construction of a PROJECT described as

which Contract is hereby by reference made a part hereof;

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION, is such that, if the Principal shall promptly, fully and faithfully perform all the undertakings, covenants, terms, conditions and agreements of said Contract during the original term of said Contract any extensions thereof that may be granted by the Principal Representative with or without notice to the Surety, and during the life of any guaranty required under the Contract, and shall also well and truly perform and fulfill all undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said Contract that may hereafter be made, notice of which modifications to the Surety being hereby waived, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

AND THE SAID SURETY, for value received hereby stipulates and agrees that whenever the Principal shall be, and declared by the Principal Representative to be in default under said Contract, the State of Colorado having performed its obligations thereunder, the Surety may promptly remedy the default or shall promptly (1) Complete the Contract in accordance with its terms and conditions, or (2) Obtain a bid or bids for submittal to the Principal Representative for completing the Contract in accordance with its terms and conditions, and upon determination by the Principal Representative and Surety of the lowest responsible bidder, arrange for a contract between such bidder and the State of Colorado acting by and through the Principal Representative and make available as work progresses (even though there should be a default or a succession of defaults under the contract or contracts of completion arranged under this paragraph) sufficient funds to pay the cost of completion, less the balance of the contract price but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the amount hereinbefore set forth. The term "balance of the contract price" as herein used shall mean the total amount payable to the Principal under the Contract and any amendments thereto, less the amount properly paid by the State of Colorado to the Contractor.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the State of Colorado.

IN WITNESS WHEREOF said Principal and Surety have executed this Bond, this _____ day of , A.D., _____ 20____

(Corporate Seal)

THE PRINCIPAL

_____

ATTEST:

By: _____

_____ Title: _____

Secretary

(Corporate Seal)

SURETY

_____

By: _____

Attorney-in-fact

THIS BOND MUST BE ACCOMPANIED BY POWER OF ATTORNEY, EFFECTIVELY DATED

Note: This bond is issued simultaneously with another bond conditioned for the full and faithful payment for all labor and material of the contract.

SECTION 00 61 13.16 – LABOR AND MATERIAL BOND

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 LABOR AND MATERIAL BOND

A. FORM: State of Colorado form “Labor and Material Bond” (SC-6.221).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURES

A. Labor and Material Bond is required for construction values of $150,000 or more.

B. This bond must be accompanied by Power of Attorney.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 61 13.16

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

LABOR AND MATERIAL BOND

Institution/Agency: University of Colorado Anschutz Medical Campus
Project No./Name: 23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades

BONDING COMPANY: DO NOT MAKE ANY CHANGES TO THE LANGUAGE IN THIS BOND.

KNOW ALL PERSONS BY THESE PRESENTS:

That the Contractor

as Principal and hereinafter called "Principal,"

and

as Surety and hereinafter called "Surety," a corporation organized and existing under the laws of _____ are held and firmly bound unto the STATE OF COLORADO acting by and through Board of Regents of the University of Colorado, a body corporate, for and on behalf of the University of Colorado Denver, hereinafter called "Principal Representative," and to all subcontractors and any others who have supplied or furnished or shall supply or furnish materials, rental machinery, tools, or equipment actually used in the performance of the hereinafter identified Contract, or who have performed or shall perform labor in the performance of or in connection with said Contract, hereinafter called "Obligees" in the sum of _____ Dollars ($_____ _____)

together with interest at the rate of eight per cent (8%) per annum on all payments becoming due in accordance with said Contract, from the time such payments shall become due until such payment shall be made, for the payment of which, well and truly made to the Obligees, the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly, by these presents.

WHEREAS, the Principal and the State of Colorado acting by and through the Principal Representative have entered into a certain Contract, hereinafter called "Contract," dated _____, 20___ for the construction of a PROJECT described as

which Contract is hereby by reference made a part hereof;

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if the Principal and the Surety shall fully indemnify and save harmless the State of Colorado and the Principal Representative from and against any and all costs and damages, including patent infringements, which either may suffer by reason of any failure or failures of the Principal promptly and faithfully to perform all terms and conditions of said Contract and shall fully reimburse and repay the State of Colorado and the Principal Representative all outlay and expense which the State of Colorado and the Principal Representative may incur in making good any such failure or failures, and further, if the Principal and his subcontractors shall duly and promptly pay for any and all labor, materials, team hire, sustenance, provisions, provender, rental machinery, tools, or equipment and other supplies which have been or shall be used or consumed by said Principal or his subcontractors in the performance of the work of said Contract , and it said Principal shall duly and promptly pay all his subcontractors the sums due them for any and all materials, rental machinery, tools, or equipment and labor that have been or shall be furnished, supplied, performed or used in connection with performance of said Contract, and shall also fully indemnify and save harmless the State of Colorado and the Principal Representative to the extent of any and all expenditures which either or both of them may be required to make by reason of any failures or defaults by the Principal or any subcontractor in connection with such payments; then this obligation shall be null and void, otherwise it shall remain in full force and effect.

It is expressly understood and agreed that any alterations which may be made in the terms of said Contract or in the work to be done under said Contract, or any extension(s) of time for the performance of the Contract, or any forebearance on the part of either the State of Colorado or the Principal to any of the others, shall not in any way release the Principal and the Surety, or either of them, their heirs, executors, administrators, successors or assigns from their liability hereunder, notice to the Surety of any such alteration, extension or forbearance being hereby waived.

IN WITNESS WHEREOF, the Principal and the Surety have executed this Bond, this _____ day of _____, A.D., 20_____.

(Corporate Seal)

THE PRINCIPAL

_____

ATTEST:

By: _____

_____ Title: _____

Secretary

(Corporate Seal)

SURETY

_____

By: _____

Attorney-in-fact

THIS BOND MUST BE ACCOMPANIED BY POWER OF ATTORNEY, EFFECTIVELY DATED

Note: This bond is issued simultaneously with another bond conditioned for the full and faithful performance of the contract.

SECTION 00 62 16 – CERTIFICATE OF INSURNACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 CERTIFICATE OF INSURANCE

A. Sample Certificate of Liability Insurance and language.

B. Sample Evidence of Property Insurance (Builder's Risk)

C. A copy of the above noted forms are attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 62 16

ACORD®

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)
CURRENT DATE

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER	CONTACT NAME:	
COMPANY ADDRESS CITY, STATE, ZIP CODE	PHONE (A/C, No, Ext):	FAX (A/C, No):
	E-MAIL ADDRESS:	
	INSURER(S) AFFORDING COVERAGE	NAIC #
	INSURER A :	
INSURED INSURED NAME INSURED ADDRESS INSURED CITY, STATE, ZIP CODE	INSURER B :	
	INSURER C :	
	INSURER D :	
	INSURER E :	
	INSURER F :	

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	[X] COMMERCIAL GENERAL LIABILITY [ ] CLAIMS-MADE [X] OCCUR [X] POLLUTION LIABILITY [ ] GEN'L AGGREGATE LIMIT APPLIES PER: [ ] POLICY [X] PRO-JECT [ ] LOC [ ] OTHER:	Y		POLICY NUMBER	01/01/2019	01/01/2020	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG [ ]	$ 1,000,000 $ $ $ 1,000,000 $ 2,000,000 $ 2,000,000 $
B	AUTOMOBILE LIABILITY [ ] ANY AUTO [X] OWNED AUTOS ONLY [ ] SCHEDULED AUTOS [X] HIRED AUTOS ONLY [X] NON-OWNED AUTOS ONLY [ ]	Y	Y	POLICY NUMBER	01/01/2019	01/01/2020	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident) [ ]	$ 1,000,000 $ $ $ $
	[ ] UMBRELLA LIAB [ ] OCCUR [ ] EXCESS LIAB [ ] CLAIMS-MADE [ ] DED [ ] RETENTION $						EACH OCCURRENCE AGGREGATE [ ]	$ $ $
D	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANYPROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? Y/N [Y] (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below	N / A	Y	POLICY NUMBER	01/01/2019	01/01/2020	[X] PER STATUTE [ ] OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	 $ 100,000 $ 100,000 $ 500,000
E	PROFESSIONAL LIABILITY		Y	POLICY NUMBER	01/01/2019	01/01/2020	Each Occurrence Aggregate	2,000,000 2,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

The Regents of the University of Colorado, a Body Corporate are named as Additional Insured as respects General, Pollution and Automobile Liability policies.

The Automobile, Workers Compensation and Professional Liability policies are endorsed to include a Waiver of Subrogation in favor of The Regents of the University of Colorado, a Body Corporate.

CERTIFICATE HOLDER

The Regents of the University of Colorado
Attn: Project Management
1945 North Wheeling Street, Campus Mail stop F-418
Aurora, CO 80045

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Authorized Representative Signature

EVIDENCE OF PROPERTY INSURANCE

DATE (MM/DD/YYYY)
CURRENT TEXT

THIS EVIDENCE OF PROPERTY INSURANCE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE ADDITIONAL INTEREST NAMED BELOW. THIS EVIDENCE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS EVIDENCE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE ADDITIONAL INTEREST.

AGENCY	PHONE (A/C, No, Ext):	COMPANY
COMPANY ADDRESS CITY, STATE, ZIP CODE		INSURANCE COMPANY
FAX (A/C, No):	E-MAIL ADDRESS:	
CODE:	SUB CODE:	
AGENCY CUSTOMER ID #:		

INSURED	LOAN NUMBER	POLICY NUMBER
INSURED NAME INSURED ADDRESS INSURED CITY, STATE, ZIP CODE		POLICY NUMBER
	EFFECTIVE DATE: 01/01/2019 — EXPIRATION DATE: 01/01/2020 — ☐ CONTINUED UNTIL TERMINATED IF CHECKED	
	THIS REPLACES PRIOR EVIDENCE DATED:	

PROPERTY INFORMATION

LOCATION/DESCRIPTION

LOCATION OF PROJECT

Builders Risk is required for new buildings or alterations to existing buildings

and for materials and equipment to be installed in existing structures.

THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS EVIDENCE OF PROPERTY INSURANCE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

COVERAGE INFORMATION

PERILS INSURED — ☐ BASIC ☐ BROAD ☒ SPECIAL ☐

COVERAGE / PERILS / FORMS	AMOUNT OF INSURANCE	DEDUCTIBLE
Builders Risk - 100% of Completed Value	100% Project Value	$50,000 or les

REMARKS (Including Special Conditions)

RE: Specific Project

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

ADDITIONAL INTEREST

NAME AND ADDRESS		
The Regents of the University of Colorado Attn: Project Management 1945 North Wheeling Street, Campus Mail stop F-418 Aurora, CO 80045	☒ ADDITIONAL INSURED ☐ LENDER'S LOSS PAYABLE ☐ LOSS PAYEE ☐ MORTGAGEE ☒ Waiver of Subrogation	LOAN # AUTHORIZED REPRESENTATIVE AUTHORIZED REPRESENTATIVE SIGNATURE

ACORD 27 (2016/03)

SECTION 00 62 76 – APPLICATION AND CERTFICIATE FOR CONTRCTORS PAYMENT FORM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

B. Related Requirements:
1. 01 29 00 – Payment Procedures

1.3 DEFINITIONS (Not Applicable)

1.4 FORMS

A. APPLICATION AND CERTIFICATE FOR CONTRACTORS PAYMENT (SBP-7.2)
1. Download Link: https://drive.google.com/open?id=0ByG39KP3LPlCVHVqenlySGJlMFE

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 62 76

SECTION 00 63 46 – CHANGE ORDER BULLETIN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

1.3 DEFINITIONS (Not Applicable)

1.4 CHANGE ORDER BULLETIN

A. State of Colorado form “Change Order Bulletin” (SC-6.311).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 63 46

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CHANGE ORDER BULLETIN

Change Order Bulletin No: _____ Date _____

Contractor: _____

Institution or Agency: _____

Project No./Name: _____

Description of Work: _____

_____

_____

_____

This bulletin is issued to define the scope of revision in drawings and/or specifications for a contemplated change order. The work called for by these revisions shall be in accordance with the requirements of the original contract documents.

Please prepare and submit a proposal for the changes described below. For pricing use State Form SC-6.312. A formal change order State Form SC-6.31 will be issued after approval of your proposal by State Buildings Program and the Architect. Your proposal shall include a statement as to the effect this change will have on the time for completion of the project.

This bulletin is **NOT** an authorization to proceed.

DESCRIPTION OF CHANGE:

SPECIFICATION REVISIONS:

STATUS OF EXISTING WORK:

PREPARED BY: _____
ARCHITECT/ENGINEER OR CONTRACTOR

APPROVED BY: _____
STATE BUILDINGS PROGRAM
(or Authorized Delegate)

SECTION 00 63 53 – CHANGE ORDER PROPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 CHANGE ORDER PROPOSAL

A. State of Colorado form “Change Order Proposal” (SC-6.312).
   1. Download link: https://drive.google.com/file/d/1Uo7i4h3LqpByA8GUYEI5K9qne_8hSwtS/view

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 63 53

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAMS

CHANGE ORDER PROPOSAL

(enter information ONLY in YELLOWED cells)

Change Order Proposal No. _____ Date _____

Change Order Bulletin No: _____

Description of Work: (enter into text box) Date _____

Contractor

Institution or Agency

Project No./Name

(Before completing this form, read instructions on reverse side.)

PART I -	**WORK PERFORMED BY CONTRACTOR**					
Line 1.	Direct Labor Costs		$			
Line 2.	Labor Overhead (Direct Labor Burdens)	(____ x Line 1)	$	0.00		
Line 3.	Total Contractor's Labor Costs (Lines 1 and 2)				$ 0.00	
Line 4.	Direct Materials Costs		$			
Line 5.	Materials Overhead (Delivery Costs & Taxes)	(____ x Line 4)	$	0.00		
Line 6.	Total Materials Costs (Lines 4 and 5)				$ 0.00	
Line 7.	Total Equipment Costs				$	
Line 8.	PART I - TOTAL CONTRACTOR'S L, M & E COSTS (Lines 3, 6 and 7)				**Part I**	$ 0.00
PART II -	**WORK PERFORMED BY SUBCONTRACTOR**					
Line 9.	Direct Labor Costs		$			
Line 10.	Labor Overhead (Direct Labor Burdens)	(____ x Line 9)	$	0.00		
Line 11.	Total Subcontractor's Labor Costs (Lines 9 and 10)				$ 0.00	
Line 12.	Direct Materials Costs					
Line 13.	Materials Overhead (Delivery Costs & Taxes)	(____ x Line 12)	$	0.00		
Line 14.	Total Subcontractor's Materials Costs (Lines 12 and 13)				$ 0.00	
Line 15.	Total Subcontractor's Equipment Costs				$	
Line 16.	Total Subcontractor's L, M & E Costs (Line 11, 14 and 15)				$ 0.00	
Line 17.	Subcontractor's Overhead (Indirect Costs)	(10.0% x Line 16)	$	0.00		
Line 18.	Subcontractor's Profit (on line 16) ☐ Addition or Deduct ☐		$	0.00		
Line 19.	PART II - TOTAL SUBCONTRACTOR'S COSTS (Lines 16, 17 and 18)				**Part II**	$ 0.00
PART III -	**CONTRACTOR'S OVERHEAD & PROFIT**					
Line 20.	Contractor's Overhead (Indirect Costs)	(10.0% x Part I Total)	$	0.00		
Line 21.	Contractor's Profit	(5.0% x Part I Total)	$	0.00		
Line 22.	PART III - TOTAL CONTRACTOR OVERHEAD & PROFIT (Lines 20 and 21)				**Part III**	$ 0.00
PART IV -	**CONTRACTOR'S MARKUP ON SUBCONTRACTOR**					
Line 23.	Contractor's Commission on Subcontractor	(5.0% x Part II Total)	$	0.00		
Line 24.	Contractor's Profit (on Line 19) ☐ Addition or Deduct ☐		$	0.00		
Line 25.	PART IV - TOTAL CONTRACTOR MARKUP ON SUBCONTRACTOR (Lines 23 and 24)				**Part IV**	$ 0.00
PART V -	**SUBTOTAL C.O. PROPOSAL (Parts I and II and III and IV)**				Part V (Subtotal)	$ 0.00
PART VI -	**CONTRACTOR'S BOND COST**	(____ x Part V Total)			Part VI	$ 0.00
PART VII -	**GRAND TOTAL CHANGE ORDER PROPOSAL (Sum of Totals: Parts V and VI)**				**Grand Total**	$ **0.00**
PART VIII -	**CONTRACT TIME (CALENDAR DAYS CHANGED)** ☐ EXTENDED ☐ NO CHANGE ☐ REDUCED					Days

THE TIME OF COMPLETION MAY CHANGE BY THE CALENDAR DAYS INDICATED (ABOVE) FROM THE TOTAL NUMBER OF DAYS LISTED IN THE CONTRACTOR'S AGREEMENT TO COMPLETE THE ENTIRE PROJECT.

CONTRACTOR'S CERTIFICATE:
This is to certify that, to the best of my knowledge and belief, the cost/price data submitted in response to the listed C.O. Bulletin, are accurate, complete and current as of _____.

Firm: _____

Name & title: _____

Signature: _____

*Date: _____

ARCHITECT/ENGINEER'S CERTIFICATE:
This is to certify that I have analyzed the proposal and find, to the best of my knowledge and belief, that the proposal represents current, fair, factual and competitive cost/price data.

Firm: _____

Name & title: _____

Signature: _____

Date: _____

* The proposal shall remain in full force and effect for a period of _____ calendar days from date of signature.

STATE BUILDINGS PROGRAMS (or Authorized Delegate)

_____ Date: _____

INSTRUCTIONS FOR COMPLETING "CHANGE ORDER PROPOSAL" COST/PRICE DATA SUMMARY (STATE FORM SC-6.312)

(enter information only in YELLOWED cells)

Enter Change Order Proposal Number, Date Created, Contractor's Name, Agency/Institution, State Project Number and Name.
REFERENCE: Enter Change Order Bulletin Number, Date Issued, and Description of Changes from Bulletin, noting exceptions which are listed in the Bulletin but are excluded, i.e., not priced on this form.

PART I - WORK PERFORMED BY CONTRACTOR:

Line 1. Direct Labor Costs: Fill in subtotal of direct labor costs which includes base rates plus applicable fringe benefits. On Contractor's (or Sub's) letterhead show costs as follows:

Trade	Rate		Duration		Extended Costs
	$	x		= $	0
	$	x		= $	0
			Direct Labor Cost	= $	0

Line 2. Labor Overhead (Direct Labor Burdens, etc,): Enter percentage (as submitted in Schedule of Values) of Line 1 as applicable. (Spread
Line 3. Total Contractor's Labor Costs: Total of Lines 1 and 2. (Spreadsheet calculates the total)

Line 4. Direct Material Cost: Support with quotes or invoices. Fill in subtotal of direct materials costs.
Include all delivery, handling, insurance costs, etc. On Contractor's letterhead show direct materials costs as follows:

Materials	Rate		Quantity		Extended Costs
	$	x		= $	0
	$	x		= $	0
			Direct Materials Cost	= $	0

Line 5. Materials Overhead (Delivery, taxes, insurance, etc. - as mutually agreed upon at contract signing):
Enter percentage as applicable. (Spreadsheet calculates the value)
Line 6. Total Contractor's Material Costs: Total of Lines 4 and 5. (Spreadsheet calculates the total)

Line 7. Total Contractor's Equipment Costs: Enter total equipment costs including indirect overhead costs in hourly rate - except indirect labor costs. On Contractor's letterhead show total equipment costs as follows:

Equipment	Rate		Duration		Extended Costs
	$	x		= $	0
	$	x		= $	0
			Total Equipment Cost	= $	0

Line 8. TOTAL CONTRACTOR'S Labor, Materials & Equipment (L, M & E) Costs: Add Lines 3, 6 and 7 of Part I.
(Spreadsheet form calculates totals)

PART II - WORK PERFORMED BY SUBCONTRACTOR:

Line 9. Direct Labor Costs: See Line 1 instructions.
Line 10. Labor Overhead (Direct Labor Burdens, etc,): Enter percentage (as submitted in Schedule of Values) of Line 9 as applicable.
(Spreadsheet calculates the value)
Line 11. Total Contractor's Labor Costs: Total of Lines 9 and 10. (Spreadsheet calculates the total)
Line 12. Direct Material Cost: See Line 4 instructions.
Line 13. Materials Overhead (Delivery, taxes, insurance, etc.) Enter percentage as applicable. (Spreadsheet calculates the value)
Line 14. Total Subcontractor's Material Costs: Total of Lines 12 and 13. (Spreadsheet calculates the total)
Line 15. Total Subcontractor's Equipment Costs: See Line 7 instructions.
Line 16. TOTAL SUBCONTRACTOR'S Labor, Materials & Equipment (L, M & E) Costs: Add Lines 11, 14 and 15 of Part II.
Line 17. Subcontractor's Overhead (Indirect costs). Edit percentage of Line 16 if applicable - See Article 35 of General Conditions.
Line 18. Subcontractor's Profit: Enter a "1" in appropriate cell. For an addition, Edit E37, a deduct, Edit I37, See Article 35 General Conditions
Line 19. TOTAL SUBCONTRACTOR'S Labor, Materials & Equipment (L, M & E) Costs: Add Lines 16, 17 and 18 of Part II.

PARTS III THROUGH VIII - CERTIFICATIONS - Self Explanatory.

Part 3. Edit percentages for Line 20 or 21 if applicable. See Article 35 of General Conditions.
Part 4. Line 23, Edit percentages applicable to Line 18. See Article 35 of General Conditions.
Part 4. Line 24, Enter a "1" in appropriate cell. For an addition, edit E45, a deduct edit I45. See Article 35 of General Conditions.
Part 5. SUBTOTAL OF CHANGE ORDER PROPOSAL (sum of lines 8, 19, 22, and 25 - applicable)
Part 6. Contractor's Bond Cost: Enter percentage value of Part 5 as applicable. (spreadsheet calculates the value)
Part 7. GRAND TOTAL OF THE CHANGE ORDER PROPOSAL. (spreadsheet calculates the sum of parts 5 and 6)
Part 8. Contract time change. Place an "X" in appropriate cell and edit the cell to indicate the number of days changed.

A. The Contractor, who prepares this proposal form, certifies the cost/price data by signing, dating, and forwarding same to the Architect/Engineer (or Consultant) for further action.

B. The Architect/Engineer (or Consultant) reviews and analyzes the cost/price data for the requirements that these are: 1) currently prevalent, 2) reasonably fair, 3) factually applicable, and 4) equivalently competitive market selling prices. The Architect/Engineer (or Consultant) may negotiate - after receipt of the cost proposal - any or all of the cost elements of the proposal to support a recommendation of acceptance to the Principal Representative. Certification by the A/E (or Consultant) of the above requirements is made upon his signature. The Architect/Engineer (or Consultant) forwards the proposal with the supporting back-up to the Agency.

C. Authority for the Institution or Agency (usually the Principal Representative) reviews the proposal, signs, dates, and forwards to Office of the State Architect for final action.

D. State Buildings Division reviews the cost proposal, with all supporting back-up, for technical and procedural requirements and, if in order, signs and dates the proposal.

SECTION 00 63 58 – CHANGE ORDER LOG

PART 1 - GENERAL

1.1 RELATED ITEMS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 CHANGE ORDER LOG

A. State of Colorado form “Change Order Log”

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 63 58

STATE BUILDINGS AND REAL ESTATE PROGRAMS
CHANGE ORDER MANAGEMENT
CHANGE ORDER LOG

Project #: _____

Project Title: _____

Contractor: _____

CO	COP	COB	INITIATION DATE	INITIATOR			DESCRIPTION	VALUE ADDED	CONT CODE	IMPACT		STATUS	REASON FOR CHANGE	RESOLUTION / COMMENT
				O	A	C				COST	TIME			

					New Contract Amount
TOTALS:	COST: ±	$0		Org Contract	
	TIME: ±		0	$0.00	$ -
				$0	$ -

Contingency Codes:

DSC - DIFFERING SITE CONDITIONS: Either encountered on site or in the building structure due to existing conditions not identified or detected during initial investigations.

BA - BID ALTERNATES: Implementation of either additive or deductive bid alternates due to favorable/unfavorable base bid results. The functionality of the project is not compromised by implementation of deductive alternates.

AV - ADDED VALUE: Change work represents essential work necessary to achieve original scope of work but was not identified in the original bid documents due to omission.

UPG - UPGRADES: Change work due to voluntary upgrading by agency/institution of materials and/or equipment/systems within original scope of work. Justification is to be based on durability, energy efficiency, aesthetics, etc.

UI - UNKNOWN ITEMS: Unforeseen costs associated with impact of project on existing functions of the agency/institution causing disruptions, shut downs, relocations, etc.

Status Codes

OPN - Open item

SUB - COP has been submitted by Contractor for review by A/E and owner

APP - Approved for processing

CLO - Closed item (CO has been processed or item voided

SECTION 00 63 64.05 – CONTRACT AMENDMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

1.3 DEFINITIONS (Not Applicable)

1.4 CHANGE ORDER BULLETIN

A. State of Colorado form “Contract Amendment” (SC-6.0A).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 63 64.05

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

CONTRACT AMENDMENT

Amendment No: _____ Contract ID No. _____

Contractor: _____

Institution or Agency: _____

Project No./Name: _____

PARTIES. THIS AMENDMENT is entered into by and between the STATE OF COLORADO, acting by and through the _____, Principal Representative, hereinafter referred to as the State, and _____ having its offices at _____ hereinafter referred to as the Contractor.

EFFECTIVE DATE AND NOTICE OF NONLIABILITY. This Amendment shall not be effective or enforceable until it is approved and signed by the State Controller or its designee (hereinafter called the "Effective Date"), but shall be effective and enforceable thereafter in accordance with its provisions. The State shall not be liable to pay or reimburse Contractor for any performance hereunder or be bound by any provision hereof prior to the Effective Date.

FACTUAL RECITALS

Authority exists in the Law and Funds have been budgeted, appropriated, and otherwise made available and a sufficient unencumbered balance thereof remains available for payment.

Required approval, clearance, and coordination has been accomplished from and with appropriate agencies; and

[Statement of facts/reasons for the Amendment]

NOW THEREFORE, it is hereby agreed that

1. Consideration for this Amendment consists of the payments, which shall be made pursuant to this Amendment and the promises, and agreements herein set forth.

2. It is expressly agreed by the parties that this Amendment is supplemental to the original Contract, as amended (_____), *collectively** referred to as the original Contract, which is incorporated by reference herein, that all provisions thereof, unless specifically modified herein, apply to this Amendment as though they were expressly re-written, incorporated, and included herein. *(*Note: only use this language if creating Amendment #2 or higher)*

3. It is agreed the original contract is and shall be modified, altered, and changed in the following respects only:

   a.
   b.
   c.

SUMMARY OF CHANGES			
	Description of Work/Date	Time of Completion/ Calendar Days Extended/Reduced	Dollar Amounts
Original Contract			
Amendment #1			
Current Total Amount of Contract (To Date):			

4. Except with respect to the "Special Provisions," in the event of any conflict, inconsistency, variance, or contradiction between the provisions of this Amendment and any of the provisions of the original contract, the provisions of this Amendment shall in all respects supersede, govern, and control. The "Special Provisions" shall always be controlling over other provisions in the contract or Amendments. The factual representations in the "Special Provisions" concerning the absence of bribery or corrupt influences and personal interest of State employees are presently reaffirmed.

5. FINANCIAL OBLIGATIONS OF THE STATE PAYABLE AFTER THE CURRENT FISCAL YEAR ARE CONTINGENT UPON FUNDS FOR THAT PURPOSE BEING APPROPRIATED, BUDGETED, AND OTHERWISE MADE AVAILABLE.

6. THIS AMENDMENT SHALL NOT BE DEEMED VALID UNTIL IT SHALL HAVE BEEN APPROVED BY THE CONTROLLER OF THE STATE OF COLORADO OR SUCH ASSISTANT AS SHE OR HE MAY DESIGNATE.

THE PARTIES HERETO HAVE EXECUTED THIS CONTRACT

Persons signing for Contractor/Consultant hereby swear and affirm that they are authorized to act on Contractor's behalf and acknowledge that the State is relying on their representations to that effect. **Principal is not a recognized title and will not be accepted.**

Project Name/Number: _____

Contract ID No.: _____

THE CONTRACTOR/CONSULTANT:

_____
Legal Name of Contracting Entity

_____
*Signature

By _____
Name (print) Title

Date: _____

STATE OF COLORADO, acting by and through:
(Insert Name of Agency or IHE)

By: _____
(Insert Name & Title of Principal Representative for Agency or IHE)

Date: _____

APPROVED
DEPARTMENT OF PERSONNEL & ADMINISTRATION
STATE BUILDINGS PROGRAM
State Architect (or authorized Delegate)

By: _____
(Insert Name of Authorized Individual)

Date: _____

APPROVED
DEPARTMENT OF LAW
ATTORNEY GENERAL (or authorized Delegate)

By: _____
(Insert Name of Authorized Individual)

Date: _____

ALL CONTRACTS MUST BE APPROVED BY THE STATE CONTROLLER:

CRS §24-30-202 requires the State Controller to approve all State Contracts. This Contract is not valid until signed and dated below by the State Controller or delegate. Contractor is not authorized to begin performance until such time. If Contractor begins performing prior thereto, the State of Colorado is not obligated to pay Contactor for such performance or for any goods and/or services provided hereunder.

APPROVED:
STATE OF COLORADO
STATE CONTROLLER'S OFFICE
State Controller (or authorized Delegate)

By: _____
(Insert Name & Title of Authorized Individual)

Date: _____

SECTION 00 65 15 – NOTICE OF PARTIAL SUBSTANTIAL COMPLETION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

1.3 DEFINITIONS (Not Applicable)

1.4 NOTICE OF PARTIAL SUBSTANTIAL COMPLETION

A. State of Colorado form “Notice of Partial Substantial Completion” (SPB-071).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 15

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

NOTICE OF PARTIAL SUBSTANTIAL COMPLETION

Date of Partial Substantial Completion: _____
Date to be inserted by the Principal Representative

Institution/Agency: _____

Project No./Name: _____

TO:

Principal Representative

and

Contractor

This is to advise you that the Work has been reviewed, inspected and determined, to the best knowledge, information and belief of the Architect/Engineer, to be substantially complete as of the date noted above in accordance with the criteria outlined in Article 41 of The General Conditions of the Contract in SC-6.23 and SC-8.1 or Article 17.3 in SC-6.4 and the Specifications, including without limitation a) suitable for occupancy, b) inspected for code compliance with Building Inspection Records signed by code officials for the State, c) determined to be fully and comfortably usable, and d) fully cleaned and appropriate for presentation to the public.

A punch list of work to be completed, work not in compliance with the Drawings or Specifications, and unsatisfactory work is attached hereto, along with the Contractor's schedule for the completion of each and every item identified on the punch list specifying the Subcontractor or trade responsible for the work, and the dates the completion or correction will be commenced and finished within any period indicated in the Agreement for punch list completion prior to Final Acceptance.

Except as stated on the reverse side of this Notice of Partial Substantial Completion, all manufacturers' warranties, other special warranties and the Contractor's one-year obligation to perform remedial work, shall commence on the Date of Substantial Completion noted above.

This Notice of Partial Substantial Completion shall be effective and establish the Date of Substantial Completion only when fully executed on the reverse by the Contractor and the Principal Representative. The Principal Representative accepts the Work as substantially complete as of the Date of Substantial Completion herein noted. The Contractor agrees to complete or correct the Work identified on the attached punch list and to do so in accordance with attached punch list completion schedule

Architect/Engineer	Date	Contractor	Date
State Buildings Program (or Authorized Delegate)	Date	Principal Representative (Institution or Agency)	Date

The responsibilities of the Principal Representative and the Contractor for security, maintenance, heat, utilities, and insurance shall be as specified in the Contract Documents or as otherwise hereafter noted:

Exceptions, if any, to the commencement of warranties shall be:

The attached final punch list consists of ____ pages, and the attached Contractor's schedule showing the dates of commencement and completion of each punch list item consists of ____ pages.

When completely executed, this form shall be sent to the Contractor and the Principal Representative with a copy to State Buildings Program.

SECTION 00 65 16 – NOTICE OF SUBSTANTIAL COMPLETION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

1.3 DEFINITIONS (Not Applicable)

1.4 CHANGE ORDER BULLETIN

A. State of Colorado form “Notice of Substantial Completion” (SPB-07).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 16

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

NOTICE OF SUBSTANTIAL COMPLETION

Date of Substantial Completion: _____
Date to be inserted by the Principal Representative

Institution/Agency: _____

Project No./Name: _____

TO:

Principal Representative

and

Contractor

This is to advise you that the Work has been reviewed, inspected and determined, to the best knowledge, information and belief of the Architect/Engineer, to be substantially complete as of the date noted above in accordance with the criteria outlined in Article 41 of The General Conditions of the Contract in SC-6.23 and SC-8.1 or Article 17.3 in SC-6.4 and the Specifications, including without limitation a) suitable for occupancy, b) inspected for code compliance with Building Inspection Records signed by code officials for the State, c) determined to be fully and comfortably usable, and d) fully cleaned and appropriate for presentation to the public.

A punch list of work to be completed, work not in compliance with the Drawings or Specifications, and unsatisfactory work is attached hereto, along with the Contractor's schedule for the completion of each and every item identified on the punch list specifying the Subcontractor or trade responsible for the work, and the dates the completion or correction will be commenced and finished within any period indicated in the Agreement for punch list completion prior to Final Acceptance.

Except as stated on the reverse side of this Notice of Substantial Completion, all manufacturers' warranties, other special warranties and the Contractor's one-year obligation to perform remedial work, shall commence on the Date of Substantial Completion noted above.

This Notice of Substantial Completion shall be effective and establish the Date of Substantial Completion only when fully executed by the Contractor and the Principal Representative. The Principal Representative accepts the Work as substantially complete as of the Date of Substantial Completion herein noted. The Contractor agrees to complete or correct the Work identified on the attached punch list and to do so in accordance with attached punch list completion schedule

Architect/Engineer	Date	Contractor	Date
State Buildings Program (or Authorized Delegate)	Date	Principal Representative (Institution or Agency)	Date

The responsibilities of the Principal Representative and the Contractor for security, maintenance, heat, utilities, and insurance shall be as specified in the Contract Documents or as otherwise hereafter noted:

Exceptions, if any, to the commencement of warranties shall be:

The attached final punch list consists of ____ pages, and the attached Contractor's schedule showing the dates of commencement and completion of each punch list item consists of ____ pages.

When completely executed, this form shall be sent to the Contractor and the Principal Representative with a copy to State Buildings Program.

SECTION 00 65 19.01 – BUILDING INSPECTION RECORD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 BUILDING INSPECTION RECORD

A. State of Colorado form "Notice of Substantial Completion" (SBP-BIR).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE

A. The University Project Manager will request building permits and provide to Contractor.

B. Permits issued outside of the University jurisdiction are the responsibility of the contractor.

C. Paper copy of the Building Inspection Record (BIR) is required to be kept at the construction site at all times. After final signoff by Building Inspector, return paper copy to University Project Manager. Project Manager is responsible for final signoff on the BIR before the Building Department can close the permit.

D. Contractor is responsible for requesting all University Building Inspector requests through the University's MyCityInspector website platform.

E. Use the following login page for requesting inspections: https://ucdenver.mycityinspector.com

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 19.01

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

BUILDING INSPECTION RECORD

Institution or Agency: _____

Project No./Name: _____

Building Official/Code Review Agent: _____ Type of Construction: _____

Architect/Engineer: _____ Occupancy Classifications: _____

Contractors: Project Manager: _____

General: _____ Project Manager Signature

Electrical: _____ At Completion: _____

Mechanical: _____ Inspector of Record Signature

Plumbing: _____ at Completion: _____

Notice to Proceed Date: _____ BIR Completion Date: _____

Provide If Checked

*** No work shall be concealed or covered until the appropriate inspector has inspected and approved.**

	Building (Consultant)	**Date**	**Inspector/ICC#**	**Comments or Corrections**
☐	Footings/Foundations			
☐	Concrete Slab / Under-Floor			
☐	Framing (after rough elec/mech/plumb)			
☐	Lath and Gypsum Board			
☐	Fire-Resistant Penetrations			
☐	Mechanical/Energy Efficiency			
☐	Roofing			
☐	Other			
☐	Final			
	Special (Consultant)	**Date**	**Inspector**	**Comments or Corrections**
☐	Steel			
☐	Concrete			
☐	Masonry			
☐	Wood			
☐	Soils/Foundations			
☐	Spray-Applied Fireproofing			
☐	Smoke Control Systems			
☐	Other			
	Elevator Inspection (State)	**Date**	**Inspector**	**Comments or Corrections**
☐	Final			
	Electrical (Co. St. Electrical Bd.)	**Date**	**Inspector**	**Comments or Corrections**
☐	Underground			
☐	Rough Walls			
☐	Rough Ceilings			
☐	Final			

	Plumbing (Co. Ex. Bd. of Plumbers)	**Date**	**Inspector**	**Comments or Corrections**
☐	Underground			
☐	Gas			
☐	Inside Water			
☐	Final			
	Fire Department Inspection (Local)	**Date**	**Inspector**	**Comments or Corrections**
☐	Fire Sprinkler System			
☐	Fire Alarm System			
☐	Other			
☐	Final			
	Health Dept. Inspection (Local)	**Date**	**Inspector**	**Comments or Corrections**
☐	Final			
	Boiler Inspection (State)	**Date**	**Inspector**	**Comments or Corrections**
☐	New Installation			
☐	Repair or Alteration			
☐	Final			

Place this card in an obvious, protected location, along with all related inspection reports and documents.

615-92-53-7997

SECTION 00 65 19.03 – NOTICE OF APPROVAL OF OCCUPANCY/USE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 NOTICE OF APPROVAL OF OCCUPANCY/USE

A. State of Colorado form “Notice of Approval of Occupancy/Use” (SBP-01).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE

PART 2 - PRODUCTS (Not (Not Applicable)Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 19.03

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

NOTICE OF APPROVAL OF OCCUPANCY/USE

Date of Occupancy: _____
Date to be inserted by the Architect/Engineer after consulation with Principal Representative

Institution/Agency: _____

Project No./Name: _____

Portion(s) of project for which occupancy is approved:

Type of Occupancy: ☐ Total or ☐ Partial

The items identified below if applicable must be completed with before Occupancy is approved.

Date Completed	A/E Signoff	
		1. The Notice of Substantial Completion has been issued and the Building Inspection Record is completely signed-off and attached.
		2a. Notification has been made to the local Fire Department concerning which portion(s) of the building will be occupied and the date(s).
		2b. Fire alarms, smoke detection systems and building fire sprinkler systems have been fully checked and are operable.
		2c. The building's fire connections must be installed and operable, if applicable.
		3. Coordination for final utility and service connections and meters (water, gas, sewer, electricity and telecommunication) has been made and systems are in full operating order.
		4. Sterilization of plumbing systems has been performed.
		5. Operational test of systems and equipment has been performed as required.
		6. Systems adjustments such as balancing, equipment operations, etc., have been performed. Reports have been submitted to the Architect/Engineer for approval.
		7. Principal Representative furnished equipment and furnishings are coordinated and placed.
		8. All elements left unfinished must be in such condition that there would be no hazard to the health or safety of the occupants.
		9. All restroom facilities must be fully functional and operable.
		10. All light fixtures must be installed and operable.

		11. All exit lights and emergency lighting systems have been checked and are operable.
		12. All windows have been glazed and hardware is available for ventilation purposes.
		13. All routes of egress must be clear of construction materials and debris at all times.
		14. There must be a means of pedestrian access to each building. Contractor must have sidewalks installed before occupancy and pedestrian barricades and other means of public protection as required.

Occupancy does not constitute acceptance of the project as being complete. It simply provides the Principal Representative the opportunity to occupy/use the project or the applicable portion thereof prior to final completion and acceptance. Occupants can expect to be impacted by the Contractor's efforts to complete the project. The Contractor would not repair any damage caused by the occupants.

Architect/Engineer	Date	Principal Representative (Institution or Agency)	Date
State Buildings Program (or Authorized Delegate)	Date	Contractor	Date

SECTION 00 65 19.23 – PRE-ACCEPTANCE CHECKLIST

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 PRE-ACCEPTANCE CHECKLIST

A. State of Colorado form “Pre-Acceptance Checklist” (SBP-05).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 19.23

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAMS

PRE-ACCEPTANCE CHECKLIST*

Institution or Agency: _____ Final Punch List Date _____
Architect/Engineer: _____
Contractor: _____
Project No./Name: _____

After Contractor is satisfied that work is complete as per Notice of Substantial Completion Punch List, a date for final review is established. Architect/Engineer inspection is made with Contractor(s) and Principal Representative and State Buildings Programs (SBP) present. Forms are processed as required.

	DATE COMPLETED	A/E SIGNOFF	REMARKS
1. The Notice of Approval of Occupancy/Use has been fully executed.			
2. Schedule for corrections, deficiencies, and items to be supplied are established by Contractor.			
3. Final Change Orders are processed (work must be completed prior to Notice of Acceptance).			
4. Punch list work is completed and accepted			
5. Permanent keying, keys and keying instructions have been performed.			
6. Extra materials as per specifications are delivered to Principal Representative.			
7. As-built drawings have been submitted to Architect/Engineer.			
8. Guarantee/Warranty documentation requirements are met.			
9. Five Most Costly Goods form is completed by Contractor and received			
10. Removal of Contractor's temporary work including cleanup and debris removal.			
11. State personnel are instructed in system and equipment operations as required by contract.			
12. All Instructions, manuals, guides, and charts have been transmitted to Principal Representative.			

Architect/Engineer Date

Contractor Date

State Buildings Programs (or Authorized Delegate) Date

Principal Representative (Institution or Agency) Date

SECTION 00 65 19.25 – NOTICE OF PARTIAL FINAL ACCEPTANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

1.3 DEFINITIONS

1.4 NOTICE OF PARTIAL FINAL ACCEPTANCE

A. State of Colorado form “Notice of Partial Final Acceptance” (SC-6.271).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 19.25

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

NOTICE OF PARTIAL FINAL ACCEPTANCE

Date of Notice of Partial Acceptance: _____

Date to be inserted by A/E after consultation with the Principal Representative

Institution/Agency: _____

Project No./Name: _____

Portion(s) of Project for which final acceptance is approved:

TO:

Notice is hereby given that the State of Colorado, acting by and through the _____, accepts as complete* the above numbered project.

State Buildings Program (or Authorized Delegate)	Date	Principal Representative (Institution or Agency)	Date

*When completely executed, this form is to be sent by certified mail to the Contractor by the Principal Representative.

SECTION 00 65 19.26 – NOTICE OF FINAL ACCEPTANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 NOTICE OF FINAL ACCEPTANCE

A. State of Colorado form “Notice of Final Acceptance” (SBP-6.27).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 19.26

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

NOTICE OF FINAL ACCEPTANCE

Date of Notice of Acceptance: _____

Date to be inserted by A/E after consultation with the Principal Representative

Institution/Agency: _____

Project No./Name: _____

TO:

Notice is hereby given that the State of Colorado, acting by and through the _____, accepts as complete* the above numbered project.

State Buildings Program (or Authorized Delegate)	Date	Principal Representative (Institution or Agency)	Date

*When completely executed, this form is to be sent by **certified mail** to the Contractor by the Principal Representative or delivered by any other means to which the parties agree.

SECTION 00 65 19.30 – NOTICE OF CONTRACTOR'S SETTLEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

1.3 DEFINITIONS

1.4 NOTICE OF CONTRACTOR'S SETTLEMENT

A. State of Colorado form "Notice of Contractor's Settlement" (SBP-7.3).

B. A copy of the above noted form is attached to the end of this section.

1.5 PROCEDURE

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 65 19.30

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

NOTICE OF CONTRACTOR'S SETTLEMENT

Institution/Agency: _____
Notice Number: _____
Project No./Title: _____

Notice is hereby given that on *date* at *address* Colorado, final settlement will be made by the STATE OF COLORADO with *vendor name*, hereinafter called the "CONTRACTOR", for and on account of the contract for the construction of a PROJECT as referenced above.

1. Any person, co-partnership, association or corporation who has an unpaid claim against the said project, for or on account of the furnishing of labor, materials, team hire, sustenance, provisions, provender, rental machinery, tools. or equipment and other supplies used or consumed by such Contractor or any of his subcontractors In or about the performance of said work, may at any time up to and including said time of such final settlement, file a verified statement of the amount due and unpaid on account of such claim

2. All such claims shall be filed with the Authority for College, Institution, Department or Agency.

3. Failure on the part of a creditor to file such statement prior to such final settlement will relieve the State of Colorado from any and all liability for such claim

Authorized Facility Manager or Authorized Individual

Name: _____
Approval Date: _____
Agency: _____
Phone: _____
Fax: _____
Email: _____

MEDIA OF PUBLICATION:

PUBLICATION DATES:
First:

Second: (At least ten (10) days prior to above settlement date)

NOTES TO EDITOR:

Transmit two (2) copies of the Affidavit of Publication, and invoice, to:

SECTION 00 72 53 – CONTRACT GENERAL CONDITIONS (D/B/B)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

1.3 DEFINITIONS (Not Applicable)

1.4 CONTRACT GENERAL CONDITIONS FOR D/B/B AGREEMENT

A. State of Colorado form “The General Conditions of the Contractor’s Design/Bid/Build (D/B/B) Agreement” (SC-6.23) dated 7/2021.

B. A copy of the above noted document is attached to the end of this section.

1.5 PROCEDURE (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 72 53

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

THE GENERAL CONDITIONS OF THE CONTRACTOR'S DESIGN/BID/BUILD (D/B/B) AGREEMENT

(STATE FORM SC-6.23)

STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

THE GENERAL CONDITIONS OF THE CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.23)

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STATE OF COLORADO
OFFICE OF THE STATE ARCHITECT
STATE BUILDINGS PROGRAM

THE GENERAL CONDITIONS OF THE CONTRACTOR'S DESIGN/BID/BUILD AGREEMENT
(STATE FORM SC-6.23)

ARTICLE 1. DEFINITIONS

CONTRACT DOCUMENTS

The Contract Documents consist of the following some of which are procedural documents used in the administration and performance of the Agreement:

1. Contractor's Design/Bid/Build Agreement; (SC-6.21);
2. Performance Bond (SC-6.22) and Labor and Material Payment Bond (SC-6.221);
3. General Conditions of the Contractor's Design/Bid/Build Agreement (SC- 6.23) and if applicable, Supplementary General Conditions;
4. Detailed Specification Requirements, including all addenda issued prior to the opening of the bids; and,
5. Drawings, including all addenda issued prior to the opening of the bids.
6. Change Orders (SC-6.31) and Amendments (SC-6.0), if any, when properly executed.
7. Authorization to Bid (SBP-6.10)
8. Information for Bidders (SBP-6.12);
9. Bid (SBP-6.13);
10. Bid Bond (SBP-6.14);
11. Notice of Award (SBP-6.15);
12. Builder's risk insurance certificates of insurance (ACORD 25-S);
13. Liability and Workers' compensation certificates of insurance;
14. Notice to Proceed (Design/Bid/Build) (SBP-6.26);
15. Notice of Approval of Occupancy/Use (SBP-01);
16. Notice of Partial Substantial Completion (SBP-071);
17. Notice of Substantial Completion (SBP-07);
18. Notice of Partial Final Acceptance (SC-6.27);
19. Notice of Final Acceptance (SBP-6.271);
20. Notice of Partial Contractor's Settlement (SC-7.3);
21. Notice of Contractor's Settlement (SBP-7.31);
22. Application and Certificate for Contractor's Payment (SBP-7.2);
23. Other procedural and reporting documents or forms referred to in the General Conditions, the Supplementary General Conditions, the Specifications or required by the State Buildings Program or the Principal Representative, including but not necessarily limited to Pre-Acceptance Check List (SBP-05) and the Building Inspection Record (SBP-BIR). A list of the current standard State Buildings Program forms applicable to this Contract may be obtained from the Principal Representative on request.

DEFINITIONS OF WORDS AND TERMS USED

1. AGREEMENT. The term "Agreement" shall mean the written agreement entered into by the State of Colorado acting by and through the Principal Representative and the Contractor for the performance of the Work and payment therefore, on State Form SC-6.21. The term Agreement when used without reference to State Form SC-6.21 may also refer to the entirety of the parties' agreement to perform the Work described in the Contract Documents or reasonably inferable there from. The term "Contract" shall be interchangeable with this latter meaning of the term Agreement
2. AMENDMENT: The term "Amendment" means a written order signed by the Principal Representative or its authorized agent, issued after the execution of this Agreement, authorizing a change in the Work, the method or manner of performance, an adjustment in the Contract Sum, or the Contract Time as required by State Building Program's policy Contract Modification Guidelines.

3. ARCHITECT/ENGINEER. The term “Architect/Engineer” shall mean either the architect of record or the engineer of record under contract to the State of Colorado for the Project identified in the Contract Documents.
4. CHANGE ORDER. The term “Change Order” means a written order directing the Contractor to make changes in the Work, in accordance with Article 35A, The Value of Changed Work.
5. COLORADO LABOR. The term “Colorado labor”, as provided in C.R.S. § 8-17-101(2)(a), as amended, means any person who is a resident of the state of Colorado, at the time of the public Works project, without discrimination as to race, color, creed, sex, sexual orientation, marital status, national origin, ancestry, age, or religion except when sex or age is a bona fide occupational qualification. A resident of the state of Colorado is a person who can provide a valid Colorado driver’s license, a valid Colorado state-issued photo identification, or documentation that he or she has resided in Colorado for the last thirty days.
6. CONTRACTOR. The word “Contractor” shall mean the person, company, firm, corporation or other legal entity entering into a contract with the State of Colorado acting by and through the Principal Representative
7. DAYS. The term “days” whether singular or plural shall mean calendar days unless expressly stated otherwise. Where the term “business days” is used it shall mean business days of the State of Colorado.
8. DRAWINGS. The term “Drawings” shall mean all drawings approved by appropriate State officials which have been prepared by the Architect/Engineer showing the Work to be done, except that where a list of drawings is specifically enumerated in the Supplementary General Conditions or division 1 of the Specifications, the term shall mean the drawings so enumerated, including all addenda drawings.
9. EMERGENCY FIELD CHANGE ORDER. The term “Emergency Field Change Order” shall mean a written change order for extra Work or a change in the Work necessitated by an emergency as defined in Article 35D executed on State form SC 6.31 and identified as an Emergency Field Change Order. The use of such orders is limited to emergencies and to the amounts shown in Article 35D.
10. FINAL ACCEPTANCE. The terms “final acceptance” or “finally complete” mean the stage in the progress of the Work, after substantial completion, when all remaining items of Work have been completed, all requirements of the Contract Documents are satisfied and the Notice of Acceptance can be issued. Discrete physical portions of the Project may be separately and partially deemed finally complete at the discretion of the Principal Representative when that portion of the Project reaches such stage of completion and a partial Notice of Acceptance can be issued.
11. FIXED LIMIT OF CONSTRUCTION COST. The term “Fixed Limit of Construction Cost” shall set forth a dollar amount available for the total Construction Cost of all elements of the Work as specified by the Principal Representative.
12. NOTICE. The term “Notice” shall mean any communication in writing from either contracting party to the other by such means of delivery that receipt cannot properly be denied. Notice shall be provided to the person identified to receive it in Article 8 of the Agreement. Notice Identification, or to such other person as either party identifies in writing to receive Notice Notwithstanding an email delivery or return receipt, email Notice shall not be adequate. Acknowledgment of receipt of a voice message shall not be deemed to waive the requirement that Notice, where required, shall be in writing.
13. OCCUPANCY. The term “Occupancy” means occupancy taken by the State as Owner after the Date of Substantial Completion at a time when a building or other discrete physical portion of the Project is used for the purpose intended. The Date of Occupancy shall be the date of such first use, but shall not be prior to the date of execution of the Notice of Approval of Occupancy/Use. Prior to the date of execution of a Notice of Approval of Occupancy/Use, the state shall have no right to occupy and the project may not be considered safe for occupancy for the intended use.

14. OWNER. The term “Owner” shall mean the Principal Representative.
15. PRINCIPAL REPRESENTATIVE. The term “Principal Representative” shall be defined, as provided in C.R.S. § 24-30-1301(14), as the governing board of a state department, institution, or agency; or if there is no governing board, then the executive head of a state department, institution, or agency, as designated by the governor or the general assembly and as specifically identified in the Contract Documents, or shall have such other meaning as the term may otherwise be given in C.R.S. § 24-30-1301(14), as amended. The Principal Representative may delegate authority. The Contractor shall have the right to inquire regarding the delegated authority of any of the Principal Representative’s representatives on the project and shall be provided with a response in writing when requested.
16. PRODUCT DATA. The term “Product Data” shall mean all submittals in the form of printed manufacturer’s literature, manufacturer’s specifications, and catalog cuts.
17. PROJECT. The "Project" is the total construction of which the Work performed under the Contract Documents is a part, and may include construction by the Principal Representative or by separate contractors.
18. REASONABLY INFERABLE. The phrase “reasonably inferable” means that if an item or system is either shown or specified, all material and equipment normally furnished with such items or systems and needed to make a complete installation shall be provided whether mentioned or not, omitting only such parts as are specifically excepted, and shall include only components which the Contractor could reasonably anticipate based on his or her skill and knowledge using an objective, industry standard, not a subjective standard. This term takes into consideration the normal understanding that not every detail is to be given on the Drawings and Specifications If there is a difference of opinion, the Principal Representative shall make the determination as to the standards of what reasonably inferable.
19. SAMPLES. The term “Samples” shall mean examples of materials or Work provided to establish the standard by which the Work will be judged.
20. SBP. The term "SBP" means "State Buildings", which is used in connection with labeling applicable State form documents (e.g., "SBP-01" is the form number for Notice of Approval of Occupancy/Use).
21. SC. The term "SC" means "State Contract" which is used in connection with labeling applicable State form documents (e.g. "SC 6.23" is the State form number for these General Conditions of the Contractor’s Design/Bid/Build Agreement).
22. SCHEDULE OF VALUES. The term “Schedule of Values” is defined as the itemized listing of description of the Work by Division and Section of the Specifications. The format shall be the same as Form SC-7.2. Included shall be the material costs, and the labor and other costs plus the sum of both.
23. SHOP DRAWINGS. The term “Shop Drawings” shall mean any and all detailed drawings prepared and submitted by Contractor, Subcontractor at any tier, vendors or manufacturers providing the products and equipment specified on the Drawings or called for in the Specifications.
24. SPECIFICATIONS. The term “Specifications” shall mean the requirements of the CSI divisions of the project manual prepared by the Architect/Engineer describing the Work to be accomplished.
25. STATE BUILDINGS PROGRAM. Shall refer to the Office of the State Architect within the Department of Personnel & Administration of Colorado State government responsible for project administration, review, approval and coordination of plans, construction procurement policy, contractual procedures, and code compliance and inspection of all buildings, public Works and improvements erected for state purposes; except public roads and highways and projects under the supervision of the division of wildlife and the division of parks and outdoor recreation as provided in C.R.S. § 24-30-1301, *et seq*. The term State Buildings Program shall also mean that individual within a State Department agency or institution, including institutions of higher education, who has signed an agreement accepting delegation to perform all or part of the responsibilities and functions of State Buildings Program.
26. SUBCONTRACTOR. The term “Subcontractor” shall mean a person, firm or corporation supplying labor, materials, equipment and/or Services for Work at the site of the Project for, and under separate contract or agreement with the Contractor.
27. SUBMITTALS. The term “submittals” means drawings, lists, tables, documents and samples prepared by the Contractor to facilitate the progress of the Work as required by these General

Conditions or the Drawings and Specifications. They consist of Shop Drawings, Product Data, Samples, and various administrative support documents including but not limited to lists of subcontractors, construction progress schedules, schedules of values, applications for payment, inspection and test results, requests for information, various document logs, and as-built drawings. Submittals are r*equired* by the Contract Documents, but except to the extent expressly specified otherwise are not themselves a part of the Contract Documents.

28. SUBSTANTIAL COMPLETION. The terms “substantial completion” or “substantially complete” mean the stage in the progress of the Work when the construction is sufficiently complete, in accordance with the Contract Documents as modified by any Change Orders, so that the Work, or at the discretion of the Principal Representative, any designated portion thereof, is available for its intended use by the Principal Representative and a Notice of Substantial Completion can be issued. Portions of the Project may, at the discretion of the Principal Representative, be designated as substantially complete.
29. SUPPLIER. The term "Supplier" shall mean any manufacturer, fabricator, distributor, material man or vendor.
30. SURETY. The term “Surety” shall mean the company providing the labor and material payment and performance bonds for the Contractor as obligor.
31. VALUE ENGINEERING. “Value Engineering” or “VE” is defined as an analysis and comparison of cost versus value of building materials, equipment, and systems. VE considers the initial cost of construction, coupled with the estimated cost of maintenance, energy use, life expectancy and replacement cost. VE related to this Project shall include the analysis and comparison of building elements in an effort to reduce overall Project costs, while maintaining or enhancing the quality of the design intent, whenever possible.
32. WORK. The term “Work” shall mean all or part of the labor, materials, equipment, and other services required by the Contract Documents or otherwise required to be provided by the Contractor to meet the Contractor’s obligations under the Contract.

ARTICLE 2. EXECUTION, CORRELATION, INTENT OF DOCUMENTS, COMMUNICATION AND COOPERATION

A. EXECUTION

The Contractor, within ten (10) days from the date of Notice of Award, will be required to:

1. Execute the Agreement, State Form SC-6.21;
2. Furnish fully executed Performance and Labor and Material Payment Bonds on State Forms SC-6.22 and SC-6.221; and
3. Furnish certificates of insurance evidencing all required insurance on standard Acord forms designed for such purpose.
4. Furnish certified copies of any insurance policies requested by the Principal Representative.
5. If Article 7.1 of the Contractor’s Design/Bid/Build Agreement (SC-6.21) applies, furnish documentation that identifies the subcontractors that will be used for all mechanical, sheet metal, fire suppression, sprinkler fitting, electrical, and plumbing work required on the project and certify that that all firms identified participate in apprenticeship programs registered with the United States Department of Labor’s Employment and Training Administration or state apprenticeship councils recognized by the United States Department of Labor and have a proven record of graduating a minimum of fifteen percent of its apprentices for at least three of the past five years;

By execution of the Agreement the Contractor represents that the Contractor has visited the site, has become familiar with local conditions and local requirements under which the Work is to be performed, including the building code programs of the State Buildings Program as implemented by the Principal Representative, and has correlated personal observations with the requirements of the Contract Documents.

C. INTENT OF DOCUMENTS

The Contract Documents are complementary, and what is called for by any one document shall be as binding as if called for by all. The intention of the documents is to include all labor, materials, equipment

and transportation necessary for the proper execution of the Work. Words describing materials or Work which have a well-known technical or trade meaning shall be held to refer to such recognized standards.

In any event, if any error exists, or appears to exist, in the requirements of the Drawings or Specifications, or if any disagreement exists as to such requirements, the Contractor shall have the same explained or adjusted by the Architect/Engineer before proceeding with the Work in question. In the event of the Contractor's failure to give prior written Notice of any such errors or disagreements of which the Contractor or the Subcontractors at any tier are aware, the Contractor shall, at no additional cost to the Principal Representative, make good any damage to, or defect in, Work which is caused by such omission.

Where a conflict occurs between or within standards, Specifications or Drawings, which is not resolved by reference to the precedence between the Contract Documents, the more stringent or higher quality requirements shall apply so long as such more stringent or higher quality requirements are reasonably inferable. The Architect/Engineer shall decide which requirements will provide the best installation.

With the exception noted in the following paragraph, the precedence of the Contract Documents is in the following sequence:

1. The Agreement (SC-6.21);
2. The Supplementary General Conditions, if any;
3. The General Conditions (SC-6.23); and
4. Drawings and Specifications, all as modified by any addenda.

Change Orders and Amendments, if any, to the Contract Documents take precedence over the original Contract Documents.

Notwithstanding the foregoing order of precedence, the Special Provisions of Article 52 of the General Conditions, Special Provisions, shall take precedence, rule and control over all other provisions of the Contract Documents.

Unless the context otherwise requires, form numbers in this document are for convenience only. In the event of any conflict between the form required by name or context and the form required by number, the form required by name or context shall control. The Contractor may obtain State forms from the Principal Representative upon request.

D. PARTNERING, COMMUNICATIONS AND COOPERATION

In recognition of the fact that conflicts, disagreements and disputes often arise during the performance of construction contracts, the Contractor and the Principal Representative aspire to encourage a relationship of open communication and cooperation between the employees and personnel of both, in which the objectives of the Contract may be better achieved and issues resolved in a more fully informed atmosphere.

The Contractor and the Principal Representative each agree to assign an individual who shall be fully authorized to negotiate and implement a voluntary partnering plan for the purpose of facilitating open communications between them. Within thirty days (30) of the Notice to Proceed, the assigned individuals shall meet to discuss development of an informal agreement to accomplish these goals.

The assigned individuals shall endeavor to reach an informal agreement, but shall have no such obligation. Any plans these parties voluntarily agree to implement shall result in no change to the contract amount, and no costs associated with such plan or its development shall be recoverable under any contract clause. In addition, no plan developed to facilitate open communication and cooperation shall alter, amend or waive any of the rights or duties of either party under the Contract unless and except by written Amendment to the Contract, nor shall anything in this clause or any subsequently developed partnering plan be deemed to create fiduciary duties between the parties unless expressly agreed in a written Amendment to the Contract. It is also recognized that projects with relatively low

contract values may not justify the expense or special efforts required. In the case of small projects with an initial Contract value under $500,000, the requirements of the preceding paragraph shall not apply.

ARTICLE 3. COPIES FURNISHED

The Contractor will be furnished, free of charge, the number of copies of Drawings and Specifications as specified in the Contract Documents, or if no number is specified, all copies reasonably necessary for the execution of the Work.

ARTICLE 4. OWNERSHIP OF DRAWINGS

Drawings or Specifications, or copies of either, furnished by the Architect/Engineer, are not to be used on any other Work. At the completion of the Work, at the written request of the Architect/Engineer, the Contractor shall endeavor to return all Drawings and Specifications.

The Contractor may retain the Contractor's Contract Document set, copies of Drawings and Specifications used to contract with others for any portion of the Work and a marked up set of as-built drawings.

ARTICLE 5. ARCHITECT/ENGINEER'S STATUS

The Architect/Engineer is the representative of the Principal Representative for purposes of administration of the Contract, as provided in the Contract Documents and the Agreement. In case of termination of employment or the death of the Architect/Engineer, the Principal Representative will appoint a capable Architect/Engineer against whom the Contractor makes no reasonable objection, whose status under the Contract shall be the same as that of the former Architect/Engineer.

ARTICLE 6. ARCHITECT/ENGINEER DECISIONS AND JUDGMENTS, ACCESS TO WORK AND INSPECTION

A. DECISIONS

The Architect/Engineer shall, within a reasonable time, make decisions on all matters relating to the execution and progress of the Work or the interpretation of the Contract Documents, and in the exercise of due diligence shall be reasonably available to the Contractor to timely interpret and make decisions with respect to questions relating to the design or concerning the Contract Documents.

B. JUDGMENTS

The Architect/Engineer is, in the first instance, the judge of the performance required by the Contract Documents as it relates to compliance with the Drawings and Specifications and quality of Workmanship and materials.

The Architect/Engineer shall make judgments regarding whether directed Work is extra or outside the scope of Work required by the Contract Documents at the time such direction is first given. If, in the Contractor's judgment, any performance directed by the Architect/Engineer is not required by the Contract Documents or if the Architect/Engineer does not make the judgment required, it shall be a condition precedent to the filing of any claim for additional cost related to such directed Work that the Contractor, before performing such Work, shall first obtain in writing, the Architect/Engineer's written decision that such directed Work is included in the performance required by the Contract Documents. If the Architect/Engineer's direction to perform the Work does not state that the Work is within the performance required by the Contract Documents, the Contractor shall, in writing, request the Architect/Engineer to advise in writing whether the directed Work will be considered extra Work or Work included in the performance required by the Contract Documents.

The Architect/Engineer shall respond to any such written request for such a decision within three (3) business days and if no response is provided, or if the Architect/Engineer's written decision is to the effect that the Work is included in the performance required by the Contract Documents, the Contractor may file with the Principal Representative and the Architect/Engineer a Notice of claim in accordance with Article 36, Claims. Whether or not a Notice of claim is filed, the Contractor shall proceed with the ordered Work. Disagreement with the decision of the Architect/Engineer shall not be grounds for the Contractor to refuse to perform the Work directed or to suspend or terminate performance.

C. ACCESS TO WORK

The Architect/Engineer, the Principal Representative and representatives of State Buildings Program shall at all times have access to the Work. The Contractor shall provide proper facilities for such access and for their observations or inspection of the Work.

D. INSPECTION

The Architect/Engineer has agreed to make, or that structural, mechanical, electrical engineers or other consultants will make, periodic visits to the site to generally observe the progress and quality of the Work to determine in general if the Work is proceeding in accordance with the Contract Documents. Observation may extend to all or any part of the Work and to the preparation, fabrication or manufacture of materials.

Without in any way meaning to be exclusive or to limit the responsibilities of the Architect/Engineer or the Contractor, the Architect/Engineer has agreed to observe, among other aspects of the Work, the following for compliance with the Contract Documents:

1. Compaction testing reports based upon the findings and recommendations of the Principal Representative's testing consultant;
2. Bearing surfaces of excavations before concrete is placed based upon the findings and recommendations of the Principal Representative's soils engineering consultant;
3. Reinforcing steel after installation and before concrete is poured;
4. Structural concrete;
5. Laboratory reports on all concrete testing based upon the findings and recommendations of the Principal Representative's testing consultant;
6. Structural steel during and after erection and prior to its being covered or enclosed;
7. Steel welding; Principal Representative will furnish steel welding inspection consultant/agency if required or necessary for the project;
8. Mechanical and plumbing Work following its installation and prior to its being covered or enclosed;
9. Electrical Work following its installation and prior to its being covered or enclosed; and
10. Any special or quality control testing required in the Contract Documents provided by the Principal Representative's testing consultant.

If the Specifications, the Architect/Engineer's instructions, laws, ordinances of any public authority require any Work to be specifically tested or approved, the Contractor shall give the Principal Representative, Architect/Engineer and appropriate testing agency (if necessary) timely notice of its readiness for observation by the Architect/Engineer or inspection by another authority, and if the inspection is by another authority, of the date fixed for such inspection, required certificates of inspection being secured by the Contractor. The Contractor shall give all required Notices to the Principal Representative or his or her designee for inspections required for the building inspection program. It shall be the responsibility of the Contractor to determine the Notice required by the State pursuant to Building Inspection Record for the Project, according to State form SBP-B.I.R., or the equivalent form required by the Principal Representative as approved by the State Buildings Program. If any portion of the Work should be covered contrary to the reasonable request of the Architect/Engineer, or to requirements specifically expressed in the Contract Documents, it must, if required in writing by the Architect/Engineer, be uncovered for its observation and shall be replaced at the Contractor's expense.

If any other portion of the Work has been covered which the Architect/Engineer has not specifically requested to observe prior to it's being covered, it may request to see such work and it shall be uncovered by the Contractor. If such work is found in accordance with the Contract Documents, the cost of uncovering and replacement shall, by appropriate Amendment or Change Order, be charged to the Principal Representative. If such work is found not in accordance with the Contract Documents, the Contractor shall pay such costs unless it is found that this condition was caused by the Principal Representative or a separate Contractor as provided in Article 18, in which event, the Principal Representative shall be responsible for the payment of such costs.

ARTICLE 7. CONTRACTOR'S SUPERINTENDENCE AND SUPERVISION

The Contractor shall employ, and keep present (as applicable) on the Project during its progress, a competent project manager as satisfactory to the Principal Representative. The project manager shall not be changed except with the consent of the Principal Representative, unless the project manager proves to be unsatisfactory to the Contractor and ceases to be in his or her employ. The project manager shall represent the Contractor for the Project, and in the absence of the Contractor, all directions given to the project manager shall be as binding as if given to the Contractor. Directions received by the project manager shall be documented by the project manager and communicated in writing with the Contractor.

The Contractor shall employ, and keep present on the Project during its progress, a competent superintendent and any necessary assistants, all satisfactory to the Architect/Engineer and the Principal Representative. The superintendent shall not be changed except with the consent of the Architect/Engineer and the Principal Representative, unless the superintendent proves to be unsatisfactory to the Project Manager/Contractor and ceases to be in his or her employ. The superintendent shall represent the Project Manager/Contractor in his or her absence and all directions given to the superintendent shall be as binding as if given to the Project Manager/Contractor. Directions received by the superintendent shall be documented by the superintendent and confirmed in writing with the Project Manager/Contractor.

The Contractor shall give efficient supervision to the Work, using his or her best skill and attention. He or she shall carefully study and compare all Drawings, Specifications and other written instructions and shall without delay report any error, inconsistency or omission which he or she may discover in writing to the Architect/Engineer. The Contractor shall not be liable to the Principal Representative for damage to the extent it results from errors or deficiencies in the Contract Documents or other instructions by the Architect/Engineer, unless the Contractor knew or had reason to know, that damage would result by proceeding and the Contractor fails to so advise the Architect/Engineer.

The superintendent shall see that the Work is carried out in accordance with the Contract Documents and in a uniform, thorough and first-class manner in every respect. The Contractor's superintendent shall establish all lines, levels, and marks necessary to facilitate the operations of all concerned in the Contractor's Work. The Contractor shall lay out all Work in a manner satisfactory to the Architect/Engineer, making permanent records of all lines and levels required for excavation, grading, foundations, and for all other parts of the Work.

ARTICLE 8. MATERIALS AND EMPLOYEES

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation and other facilities necessary for the execution and completion of the Work.

Unless otherwise specified, all materials shall be new and both workmanship and materials shall be first class and of uniform quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

The Contractor is fully responsible for all acts and omissions of the Contractor's employees and shall at all times enforce strict discipline and good order among employees on the site. The Contractor shall not employ on the Work any person reasonably deemed unfit by the Principal Representative or anyone not skilled in the Work assigned to him.

ARTICLE 9. SURVEYS, PERMITS, LAWS, TAXES AND REGULATIONS

A. SURVEYS

The Principal Representative shall furnish all surveys, property lines and bench marks deemed necessary by the Architect/Engineer, unless otherwise specified.

B. PERMITS AND LICENSES

Permits and licenses necessary for the prosecution of the Work shall be secured and paid for by the Contractor. Unless otherwise specified in the Specifications, no local municipal or county building permit shall be required. However, State Buildings Program requires each Principal Representative to administer a building code inspection program, the implementation of which may vary at each agency

or institution of the State. The Contractors' employees shall become personally familiar with these local conditions and requirements and shall fully comply with such requirements. State electrical and plumbing permits are required, unless the requirement to obtain such permits is altered by State Building's Programs. The Contractor shall obtain and pay for such permits.

Easements for permanent structures or permanent changes in existing facilities shall be secured and paid for by the Principal Representative, unless otherwise specified.

C. TAXES

1. Refund of Sales and Use Taxes

The Contractor shall pay all local taxes required to be paid, including but not necessarily limited to all sales and use taxes. If requested by the Principal Representative prior to issuance of the Notice to Proceed or directed in the Supplementary General Conditions or the Specifications, the Contractor shall maintain records of such payments in respect to the Work, which shall be separate and distinct from all other records maintained by the Contractor, and the Contractor shall furnish such data as may be necessary to enable the State of Colorado, acting by and through the Principal Representative, to obtain any refunds of such taxes which may be available under the laws, ordinances, rules or regulations applicable to such taxes. When so requested or directed, the Contractor shall require Subcontractors at all tiers to pay all local sales and use taxes required to be paid and to maintain records and furnish the Contractor with such data as may be necessary to obtain refunds of the taxes paid by such Subcontractors. No State sales and use taxes are to be paid on material to be used in this Project. On application by the purchaser or seller, the Department of Revenue shall issue to a Contractor or to a Subcontractor at any tier, a certificate or certificates of exemption per C.R.S. § 39-26-703(2)(b), and C.R.S. § 39-26-708.

2. Federal Taxes

The Contractor shall exclude the amount of any applicable federal excise or manufacturers' taxes from the proposal. The Principal Representative will furnish the Contractor, on request exemption certificates.

D. LAWS AND REGULATIONS

The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the Work as drawn or specified. If the Contractor observes that the Drawings or Specifications require Work which is at variance therewith, the Contractor shall without delay notify the Architect/Engineer in writing and any necessary changes shall be adjusted as provided in Article 35, Changes In The Work.

The Contractor shall bear all costs arising from the performance of Work required by the Drawings or Specifications that the Contractor knows to be contrary to such laws, ordinances, rules or regulations, if such Work is performed without giving Notice to the Architect/Engineer.

ARTICLE 10. PROTECTION OF WORK AND PROPERTY

A. GENERAL PROVISIONS

The Contractor shall continuously maintain adequate protection of all Work and materials, protect the property from injury or loss arising in connection with this Contract and adequately protect adjacent property as provided by law and the Contract Documents. The Contractor shall make good any damage, injury or loss, except to the extent:

1. Directly due to errors in the Contract Documents;
2. Caused by agents or employees of the Principal Representative; and,
3. Due to causes beyond the Contractor's control and not to fault or negligence; provided such damage, injury or loss would not be covered by the insurance required to be carried by the Contractor;

B. SAFETY PRECAUTIONS

The Contractor shall take all necessary precautions for the safety of employees on the Project, and shall comply with all applicable provisions of federal, State and municipal safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the Work is being performed. He or she shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all necessary safeguards for the protection of Workers and the public and shall post danger signs warning against the hazards created by such features of construction as protruding nails, hoists, well holes, elevator hatchways, scaffolding, window openings, stairways and falling materials; and he or she shall designate a responsible member of his or her organization on the Project, whose duty shall be the prevention of accidents. The name and position of any person so designated shall be reported to the Architect/Engineer by the Contractor.

The Contractor shall provide all necessary bracing, shoring and tying of all structures, decks and framing to prevent any structural failure of any material which could result in damage to property or the injury or death of persons; take all precautions to insure that no part of any structure of any description is loaded beyond its carrying capacity with anything that will endanger its safety at any time during the execution of this Contract; and provide for the adequacy and safety of all scaffolding and hoisting equipment. The Contractor shall not permit open fires within the building enclosure. The Contractor shall construct and maintain all necessary temporary drainage and do all pumping necessary to keep excavations and floors, pits and trenches free of water. The Contractor shall be solely responsible for all construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the Work, except as otherwise noted.

The Contractor shall take due precautions when obstructing sidewalks, streets or other public ways in any manner, and shall provide, erect and maintain barricades, temporary walkways, roadways, trench covers, colored lights or danger signals and any other devices necessary or required to assure the safe passage of pedestrians and automobiles.

C. EMERGENCIES

In an emergency affecting the safety of life or of the Work or of adjoining property, the Contractor without special instruction or authorization from the Architect/Engineer or Principal Representative, is hereby permitted to act, at his or her discretion, to prevent such threatened loss or injury; and he or she shall so act, without appeal, if so authorized or instructed. Provided the Contractor has no responsibilities for the emergency, if the Contractor incurs additional cost not otherwise recoverable from insurance or others on account of any such emergency Work, the Contract sum shall be equitably adjusted in accordance with Article 35, Changes In The Work.

ARTICLE 11. DRAWINGS AND SPECIFICATIONS ON THE WORK

The Contractor shall keep on the job site one copy of the Contract Documents in good order, including current copies of all Drawings and Specifications for the Work, and any approved Shop Drawings, Product Data or Samples, and as-built drawings. As-built drawings shall be updated weekly by the Contractor and Subcontractors to reflect actual constructed conditions including dimensioned locations of underground Work and the Contractor's failure to maintain such updates may be grounds to withhold portions of payments otherwise due in accordance with Article 33, Payments Withheld. All such documents shall be available to the Architect/Engineer and representatives of the State. In addition, the Contractor shall keep on the job site one copy of all approved addenda, Change Orders and requests for information issued for the Work.

The Contractor shall develop procedures to insure the currency and accuracy of as-built drawings and shall maintain on a current basis a log of requests for information and responses thereto, a Shop Drawing and Product Data submittal log, and a Sample submittal log to record the status of all necessary and required submittals.

ARTICLE 12. REQUESTS FOR INFORMATION AND SCHEDULES

A. REQUESTS FOR INFORMATION

The Architect/Engineer shall furnish additional instructions with reasonable promptness, by means of drawings or otherwise, necessary for the proper execution of the Work. All such drawings and

instructions shall be consistent with the Contract Documents and reasonably inferable there from. The Architect/Engineer shall determine what additional instructions or drawings are necessary for the proper execution of the Work.

The Work shall be executed in conformity with such instructions and the Contractor shall do no Work without proper drawings, specifications or instructions. If the Contractor believes additional instructions, specifications or drawings are needed for the performance of any portion of the Work, the Contractor shall give Notice of such need in writing through a request for information furnished to the Architect/Engineer sufficiently in advance of the need for such additional instructions, specifications or drawings to avoid delay and to allow the Architect/Engineer a reasonable time to respond. The Contractor shall maintain a log of the requests for information and the responses provided.

B. SCHEDULES

1. Submittal Schedules

Prior to filing the Contractor 's first application for payment, a schedule shall be prepared which may be preliminary to the extent required, fixing the dates for the submission and initial review of required Shop Drawings, Product Data and Samples for the beginning of manufacture and installation of materials, and for the completion of the various parts of the Work. It shall be prepared so as to cause no delay in the Work or in the Work of any other contractor. The schedule shall be subject to change from time to time in accordance with the progress of the Work, and it shall be subject to the review and approval by the Architect/Engineer. It shall fix the dates at which the various Shop Drawings Product Data and Samples will be required from the Architect/Engineer. The Architect/Engineer, after review and agreement as to the time provided for initial review, shall review and comment on the Shop Drawings, Product Data and Samples in accordance with that schedule. The schedule shall be finalized, prepared and submitted with respect to each of the elements of the Work in time to avoid delay, considering reasonable periods for review, manufacture or installation.

At the time the schedule is prepared, the Contractor, the Architect/Engineer and Principal Representative shall jointly identify the Shop Drawing, Product Data and Samples, if any, which the Principal Representative shall receive simultaneously with the Architect/Engineer for the purposes of owner coordination with existing facility standards and systems. The Contractor shall furnish a copy for the Principal Representative when so requested. Transmittal of Shop Drawings and Product Data copies to the Principal Representative shall be solely for the convenience of the Principal Representative and shall neither create nor imply responsibility or duty of review by the Principal Representative.

The Contractor may also, or at the direction of the Principal Representative at any time shall, prepare and maintain a schedule, which may also be preliminary and subject to change to the extent required, fixing the dates for the initial responses to requests for information or for detail drawings which will be required from the Architect/Engineer to allow the beginning of manufacture, installation of materials and for the completion of the various parts of the Work. The schedule shall be subject to review and approval by the Architect/Engineer. The Architect/Engineer shall, after review and agreement, furnish responses and detail drawings in accordance with that schedule. Any such schedule shall be prepared and approved in time to avoid delay, considering reasonable periods for review, manufacture or installation, but so long as the request for information schedule is being maintained, it shall not be deemed to transfer responsibility to the Contractor for errors or omissions in the Contract Documents where circumstances make timely review and performance impossible.

The Architect/Engineer shall not unreasonably withhold approval of the Contractor's schedules and shall inform the Contractor and the Principal Representative of the basis of any refusal to agree to the Contractor's schedules. The Principal Representative shall attempt to resolve any disagreements.

2. Schedule of Values

Within twenty-one (21) calendar days after the date of the Notice to Proceed, the Contractor shall submit to the Architect/Engineer and Principal Representative, for approval, and to the State Buildings Program when specifically requested, a complete itemized schedule of the values of the various parts of the Work, as estimated by the Contractor, aggregating the total price. The schedule of values shall be in such detail as the Architect/Engineer or the Principal Representative shall require, prepared on forms acceptable to the Principal Representative. It shall, at a minimum, identify on a separate line each division of the Specifications including the general conditions costs to be charged to the Project. The Contractor shall revise and resubmit the schedule of values for approval when, in the opinion of the Architect/Engineer or the Principal Representative, such resubmittal is required due to changes or modifications to the Contract Documents or the Contract sum.

The total cost of each line item so separately identified shall, when requested by the Architect/Engineer or the Principal Representative, be broken down into reasonable estimates of the value of:

a. Material, which shall include the cost of material actually built into the Project plus any local sales or use tax paid thereon; and,
b. Labor and other costs.

The cost of subcontracts shall be incorporated in the Contractor's schedule of values, and when requested by the Architect/Engineer or the Principal Representative, shall be separately shown as line items.

The Architect/Engineer shall review the proposed schedules and approve it after consultation with the Principal Representative, or advise the Contractor of any required revisions within ten (10) days of its receipt. In the event no action is taken on the submittal within ten days, the Contractor may utilize the schedule of values as its submittal for payment until it is approved or until revisions are requested.

When the Architect/Engineer deems it appropriate to facilitate certification of the amounts due to the Contractor, further breakdown of subcontracts, including breakdown by labor and materials, may be directed.

This schedule of values, when approved, will be used in preparing Contractor's applications for payment on State Form SC-7.2, Application for Payment.

3. Construction Schedules

Within twenty-one (21) calendar days after the date of the Notice to Proceed, the Contractor shall submit to the Architect/Engineer and the Principal Representative, and to the State Buildings Program when specifically requested, on a form acceptable to them, an overall timetable of the construction schedule for the Project. Unless the Supplementary General Conditions or the Specifications allow scheduling with bar charts or other less sophisticated scheduling tools, the Contractor's schedule shall be a critical-path method (CPM) construction schedule. The CPM schedule shall start with the date of the Notice to Proceed and include submittals activities, the various construction activities, change order Work (when applicable), close-out, testing, demonstration of equipment operation when called for in the Specifications, and acceptance. The CPM schedule shall at a minimum correlate to the schedule of values line items and shall be cost loaded if requested by the Architect/Engineer or Principal Representative. The completion time shall be the time specified in the Agreement and all Project scheduling shall allocate float utilizing the full period available for construction as specified in the Agreement on State Form SC 6.13, without indication of early completion, unless such earlier completion is approved in writing by the Principal Representative and State Building Programs.

The time shown between the starting and completion dates of the various elements within the construction schedule shall represent one hundred per cent (100%) completion of each element.

All other elements of the CPM schedule shall be as required by the Specifications. In addition, the Contractor shall submit monthly updates or more frequently, if required by the Principal Representative, updates of the construction schedule. These updates shall reflect the Contractor's "Work in place" progress.

When requested by the Architect/Engineer, the Principal Representative or the State Buildings Program, the Contractor shall revise the construction schedule to reflect changes in the schedule of values.

When the testing of materials is required by the Specifications, the Contractor shall also prepare and submit to the Architect/Engineer and the Principal Representative a schedule for testing in accordance with Article 14, Samples and Testing.

ARTICLE 13. SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

A. SUBMITTAL PROCESS

The Contractor shall check and field verify all dimensions. The Contractor shall check, approve and submit to the Architect/Engineer in accordance with the schedule described in Article 12, Requests for Information and Schedules, all Shop Drawings, Product Data and Samples required by the specifications or required by the Contractor for the Work of the various trades. All Drawings and Product Data shall contain identifying nomenclature and each submittal shall be accompanied by a letter of transmittal identifying in detail all enclosures. The number of copies of Shop Drawings and Product Data to be submitted shall be as specified in the Specifications and if no number is specified then three copies shall be submitted.

The Architect/Engineer shall review and comment on the Shop Drawings and Product Data within the time provided in the agreed upon schedule for conformance with information given and the design concept expressed in, or reasonably inferred from, the Contract Documents. The nature of all corrections to be made to the Shop Drawings and Product Data, if any, shall be clearly noted, and the submittals shall be returned to the Contractor for such corrections. If a change in the scope of the Work is intended by revisions requested to any Shop Drawings and Product Data, the Contractor shall be requested to prepare a change proposal in accordance with Article 35, Changes In The Work. On resubmitted Shop Drawings, Product Data or Samples, the Contractor shall direct specific attention in writing on the transmittal cover to revisions other than those corrections requested by the Architect/Engineer on any previously checked submittal. The Architect/Engineer shall promptly review and comment on, and return, the resubmitted items.

The Contractor shall thereafter furnish such other copies in the form approved by the Architect/Engineer as may be needed for the prosecution of the Work.

B. FABRICATION AND ORDERING

Fabrication shall be started by the Contractor only after receiving approved Shop Drawings from the Architect/Engineer. Materials shall be ordered in accordance with approved Product Data. Work which is improperly fabricated, whether through incorrect Shop Drawings, faulty workmanship or materials, will not be acceptable.

C. DEVIATIONS FROM DRAWINGS OR SPECIFICATIONS

The review and comments of the Architect/Engineer of Shop Drawings, Product Data or Samples shall not relieve the Contractor from responsibility for deviations from the Drawings or Specifications, unless he or she has in writing called the attention of the Architect/Engineer to such deviations at the time of submission, nor shall it relieve the Contractor from responsibility for errors of any sort in Shop Drawings or Product Data. Review and comments on Shop Drawings or Product Data containing identified deviations from the Contract Documents shall not be the basis for a Change Order or a claim based on a change in the scope of the Work unless Notice is given to the Architect/Engineer and Principal Representative of all additional costs, time and other impacts of the identified deviation by bring it to their attention in writing at the time the submittals are made, and any subsequent change in the Contract sum or the Contract time shall be limited to cost, time and impacts so identified.

D. CONTRACTOR REPRESENTATIONS

By preparing, approving, and/or submitting Shop Drawings, Product Data and Samples, the Contractor represents that the Contractor has determined and verified all materials, field measurements, and field construction criteria related thereto, and has checked and coordinated the information contained within each submittal with the requirements of the Work, the Project and the Contract Documents and prior reviews and approvals.

ARTICLE 14. SAMPLES AND TESTING

A. SAMPLES

The Contractor shall furnish for approval, with such promptness as to cause no delay in his or her Work or in that of any other Contractor, all Samples as directed by the Architect/Engineer. The Architect/Engineer shall check and approve such Samples, with reasonable promptness, but only for conformance with the design intent of the Contract Documents and the Project, and for compliance with any submission requirements given in the Contract Documents.

B. TESTING - GENERAL

The Contractor shall provide such equipment and facilities as the Architect/Engineer may require for conducting field tests and for collecting and forwarding samples to be tested. Samples themselves shall not be incorporated into the Work after approval without the permission of the Architect/Engineer.

All materials or equipment proposed to be used may be tested at any time during their preparation or use. The Contractor shall furnish the required samples without charge and shall give sufficient Notice of the placing of orders to permit the testing thereof. Products may be sampled either prior to shipment or after being received at the site of the Work.

Tests shall be made by an accredited testing laboratory. Except as otherwise provided in the Specifications, sampling and testing of all materials, and the laboratory methods and testing equipment, shall be in accordance with the latest standards and tentative methods of the American Society of Testing Materials (ASTM). The cost of testing which is in addition to the requirements of the Specifications shall be paid by the Contractor if so directed by the Architect/Engineer, and the Contract sum shall be adjusted accordingly by Change Order; provided however, that whenever testing shows portions of the Work to be deficient, all costs of testing including that required to verify the adequacy of repair or replacement Work shall be the responsibility of the Contractor.

C. TESTING - CONCRETE AND SOILS

Unless otherwise specified or provided elsewhere in the Contract Documents, the Principal Representative will contract for and pay for the testing of concrete and for soils compaction testing through an independent laboratory or laboratories selected and approved by the Principal Representative. The Contractor shall assume the responsibility of arranging, scheduling and coordinating the concrete sample collection efforts and soils compaction efforts in an efficient and cost effective manner. Testing shall be performed in accordance with the requirements of the Specifications, and if no requirements are specified, the Contractor shall request instructions and testing shall be as directed by the Architect/Engineer or the soils engineer, as applicable, and in accordance with standard industry practices.

The Principal Representative and the Architect/Engineer shall be given reasonable advance notice of each concrete pour and reserve the right to either increase or decrease the number of cylinders or the frequency of tests.

Soil compaction testing shall be at random locations selected by the soils engineer. In general, soils compaction testing shall be as directed by the soils engineer and shall include all substrate prior to backfill or construction.

D. TESTING - OTHER

Additional testing required by the Specifications will be accomplished and paid for by the Principal Representative in a manner similar to that for concrete and soils unless noted otherwise in the Specifications. In any case, the Contractor will be responsible for arranging, scheduling and coordinating additional tests. Where the additional testing will be contracted and paid for by the Principal Representative the Contractor shall give the Principal Representative not less than one-month advance written Notice of the date the first such test will be required.

ARTICLE 15. SUBCONTRACTS

A. CONTRACT PERFORMANCE OUTSIDE OF THE UNITED STATES OR COLORADO

After the contract is awarded, Contractor is required to provide written notice to the Principal Representative no later than twenty (20) days after deciding to perform services under this contract outside the United States or Colorado or to subcontract services under this contract to a subcontractor that will perform such services outside the United States or Colorado. The written notification must include, but need not be limited to, a statement of the type of services that will be performed at a location outside the United States or Colorado and the reason why it is necessary or advantageous to go outside the United States or Colorado to perform the services. All notices received by the State pursuant to outsourced services shall be posted on the Colorado Department of Personnel & Administration's website. If Contractor knowingly fails to notify the Principal Representative of any outsourced services as specified herein, the Principal Representative, at its discretion, may terminate this contract as provided in the Colorado Procurement Code or the applicable procurement code for institutions of higher education (Does not apply to any project that receives federal moneys)

B. SUBCONTRACTOR LIST

Prior to the Notice to Proceed to commence construction, the Contractor shall submit to the Architect/Engineer, the Principal Representative and State Buildings Program a preliminary list of Subcontractors. It shall be as complete as possible at the time, showing all known Subcontractors planned for the Work. The list shall be supplemented as other Subcontractors are determined by the Contractor and any such supplemental list shall be submitted to the Architect/Engineer, the Principal Representative and State Buildings Program not less than ten (10) days before the Subcontractor commences Work.

C. SUBCONTRACTOR SUBSTITUTIONS

The Contractor's list shall include those Subcontractors, if any, which the Contractor indicated in its bid, would be employed for specific portions of the Work if such indication was requested in the bid documents issued by the State. The substitution of any Subcontractor listed in the Contractor's bid shall be justified in writing not less than ten (10) days after the date of the Notice to Proceed to commence construction, and shall be subject to the approval of the Principal Representative. For reasons such as the Subcontractor's refusal to perform as agreed, subsequent unavailability or later discovered bid errors, or other similar reasons, but not including the availability of a lower Subcontract price, such substitution may be approved. The Contractor shall bear any additional cost incurred by such substitutions.

D. CONTRACTOR RESPONSIBLE FOR SUBCONTRACTORS

The Contractor shall not employ any Subcontractor that the Architect/Engineer, within ten (10) days after the date of receipt of the Contractor's list of Subcontractors or any supplemental list, objects to in writing as being unacceptable to either the Architect/Engineer, the Principal Representative or State Buildings Program. If a Subcontractor is deemed unacceptable, the Contractor shall propose a

substitute Subcontractor and the Contract sum shall be adjusted by any demonstrated difference between the Subcontractor's bids, except where the Subcontractor has been debarred by the State or fails to meet qualifications of the Contract Documents to perform the Work proposed.

The Contractor shall be fully responsible to the Principal Representative for the acts and omissions of Subcontractors and of persons either directly or indirectly employed by them. All instructions or orders in respect to Work to be done by Subcontractors shall be given to the Contractor.

ARTICLE 16. RELATIONS OF CONTRACTOR AND SUBCONTRACTOR

The Contractor agrees to bind each Subcontractor to the terms of these General Conditions and to the requirements of the Drawings and Specifications, and any Addenda thereto, and also all the other Contract Documents, so far as applicable to the Work of such Subcontractor. The Contractor further agrees to bind each Subcontractor to those terms of the General Conditions which expressly require that Subcontractors also be bound, including without limitation, requirements that Subcontractors waive all rights of subrogation, provide adequate general commercial liability and property insurance, automobile insurance and workers' compensation insurance as provided in Article 25, Insurance.

Nothing contained in the Contract Documents shall be deemed to create any contractual relationship whatsoever between any Subcontractor and the State of Colorado acting by and through its Principal Representative.

ARTICLE 17. MUTUAL RESPONSIBILITY OF CONTRACTORS

Should the Contractor cause damage to any separate contractor on the Work, the Contractor agrees, upon due Notice, to settle with such contractor by agreement, if he or she will so settle. If such separate contractor sues the Principal Representative on account of any damage alleged to have been so sustained, the Principal Representative shall notify the Contractor, who shall defend such proceedings if requested to do so by Principal Representative. If any judgment against the Principal Representative arises there from, the Contractor shall pay or satisfy it and pay all costs and reasonable attorney fees incurred by the Principal Representative, in accordance with Article 52C, Indemnification, provided the Contractor was given due Notice of an opportunity to settle.

ARTICLE 18. SEPARATE CONTRACTS

The Principal Representative reserves the right to enter into other contracts in connection with the Project or the Contract. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their Work, and shall properly connect and coordinate his or her Work with theirs. If any part of the Contractor's Work depends, for proper execution or results, upon the Work of any other contractor, the Contractor shall inspect and promptly report to the Architect/Engineer any defects in such Work that render it unsuitable for such proper execution and results. Failure of the Contractor to so inspect and report shall constitute an acceptance of the other contractor's Work as fit and proper for the reception of Work, except as to defects which may develop in the other Contractor's Work after the execution of the Contractor's Work.

To insure the proper execution of subsequent Work, the Contractor shall measure Work already in place and shall at once report to the Architect/Engineer any discrepancy between the executed Work and the Drawings.

ARTICLE 19. USE OF PREMISES

The Contractor shall confine apparatus, the storage of materials and the operations of workmen to limits indicated by law, ordinances, permits and any limits lines shown on the Drawings. The Contractor shall not unreasonably encumber the premises with materials.

The Contractor shall enforce all of the Architect/Engineer's instructions and prohibitions regarding, without limitation, such matters as signs, advertisements, fires and smoking.

ARTICLE 20. CUTTING, FITTING OR PATCHING

The Contractor shall do all cutting, fitting or patching of Work that may be required to make its several parts come together properly and fit it to receive or be received by Work of other Contractors shown upon, or

reasonably inferred from, the Drawings and Specifications for the complete structure, and shall provide for such finishes to patched or fitted Work as the Architect/Engineer may direct. The Contractor shall not endanger any Work by cutting, excavating or otherwise altering the Work and shall not cut or alter the Work of any other Contractor save with the consent of the Architect/Engineer.

ARTICLE 21. UTILITIES

A. TEMPORARY UTILITIES

Unless otherwise specifically stated in the Specifications or on the Drawings, the Principal Representative shall be responsible for the locations of all utilities as shown on the Drawings or indicated elsewhere in the Specifications, subject to the Contractor's compliance with all statutory or regulatory requirements to call for utility locates. When actual conditions deviate from those shown the Contractor shall comply with the requirements of Article 37, Differing Site Conditions. The Contractor shall provide and pay for the installation of all temporary utilities required to supply all the power, light and water needed by him and other Contractors for their Work and shall install and maintain all such utilities in such manner as to protect the public and Workmen and conform with any applicable laws and regulations. Upon completion of the Work, he or she shall remove all such temporary utilities from the site. The Contractor shall pay for all consumption of power, light and water used by him or her and the other Contractors, without regard to whether such items are metered by temporary or permanent meters. The Superintendent shall have full authority over all trades and Subcontractors at any tier to prevent waste. The cut-off date on permanent meters shall be either the agreed date of the date of the Notice of Substantial Completion or the Notice of Approval of Occupancy/Use of the Project.

B. PROTECTION OF EXISTING UTILITIES

Where existing utilities, such as water mains, sanitary sewers, storm sewers and electrical conduits, are shown on the Drawings, the Contractor shall be responsible for the protection thereof, without regard to whether any such utilities are to be relocated or removed as a part of the Work. If any utilities are to be moved, the moving must be conducted in such manner as not to cause undue interruption or delay in the operation of the same.

C. CROSSING OF UTILITIES

When new construction crosses highways, railroads, streets, or utilities under the jurisdiction of State, city or other public agency, public utility or private entity, the Contractor shall secure proper written permission before executing such new construction. The Contractor will be required to furnish a proper release before final acceptance of the Work.

ARTICLE 22. UNSUITABLE CONDITIONS

The Contractor shall not Work at any time, or permit any Work to be done, under any conditions contrary to those recommended by manufacturers or industry standards which are otherwise proper, unsuited for proper execution, safety and performance. Any cost caused by ill-timed Work shall be borne by the Contractor unless the timing of such Work shall have been directed by the Architect/Engineer or the Principal Representative, after the award of the Contract, and the Contractor provided Notice of any additional cost.

ARTICLE 23. TEMPORARY FACILITIES

A. OFFICE FACILITIES

The Contractor shall provide and maintain without additional expense for the duration of the Project temporary office facilities, as required and as specified, for its own use and the use of the Architect/Engineer, representatives of the Principal Representative and State Buildings Program.

B. TEMPORARY HEAT

The Contractor shall furnish and pay for all the labor, facilities, equipment, fuel and power necessary to supply temporary heating, ventilating and air conditioning, except to the extent otherwise specified, and shall be responsible for the installation, operation, maintenance and removal of such facilities and equipment. Unless otherwise specified, the permanent HVAC system shall not be used for temporary heat in whole or in part. If the Contractor desires to put the permanent system into use, in whole or in part, the Contractor shall set it into operation and furnish the necessary fuel and manpower to safely operate, protect and maintain that HVAC system. Any operation of all or any part of the permanent

HVAC system including operation for testing purposes shall not constitute acceptance of the system, nor shall it relieve the Contractor of his or her one-year guarantee of the system from the date of the Notice of Substantial Completion of the entire Project, and if necessary due to prior operation, the Contractor shall provide manufacturers' extended warranties from the date of the Contractor's use prior to the date of the Notice of Substantial Completion.

C. WEATHER PROTECTION

The Contractor shall, at all times, provide protection against weather, so as to maintain all Work, materials, apparatus and fixtures free from injury or damages.

D. DUST PARTITIONS

If the Work involves Work in an occupied existing building, the Contractor shall erect and maintain during the progress of the Work, suitable dust-proof temporary partitions, or more permanent partitions as specified, to protect such building and the occupants thereof.

E. BENCH MARKS

The Contractor shall maintain any site bench marks provided by the Principal Representative and shall establish any additional benchmarks specified by the Architect/Engineer as necessary for the Contractor to layout the Work and ascertain all grades and levels as needed.

F. SIGN

The Contractor shall erect and permit one 4' x 8' sign only at the site to identify the Project as specified or directed by the Architect/Engineer which shall be maintained in good condition during the life of the Project.

G. SANITARY PROVISION

The Contractor shall provide and maintain suitable, clean, temporary sanitary toilet facilities for any and all workmen engaged on the Work, for the entire construction period, in strict compliance with the requirement of all applicable codes, regulations, laws and ordinances, and no other facilities, new or existing, may be used by any person on the Project. When the Project is complete the Contractor shall promptly remove them from the site, disinfect, and clean or treat the areas as required. If any new construction surfaces in the Project other than the toilet facilities provided for herein are soiled at any time, the entire areas so soiled shall be completely removed from the Project and rebuilt. In no event may present toilet facilities of any existing building at the site of the Work be used by employees of any contractor.

ARTICLE 24. CLEANING UP

The Contractor shall keep the building and premises free from all surplus material, waste material, dirt and rubbish caused by employees or Work, and at the completion of the Work shall remove all such surplus material, waste material, dirt, and rubbish, as well as all tools, equipment and scaffolding, and shall wash and clean all window glass and plumbing fixtures, perform cleanup and cleaning required by the Specifications and leave all of the Work clean unless more exact requirements are specified.

ARTICLE 25. INSURANCE

A. GENERAL

The Contractor shall procure and maintain all insurance requirements and limits as set forth below, at his or her own expense, for the length of time set forth in Contract requirements. The Contractor shall continue to provide evidence of such coverage to State of Colorado on an annual basis during the aforementioned period including all of the terms of the insurance and indemnification requirements of this agreement. All below insurance policies shall include a provision preventing cancellation without thirty (30) days' prior notice by certified mail. A completed Certificate of Insurance shall be filed with the Principal Representative and State Buildings Program within ten (10) days after the date of the Notice of Award, said Certificate to specifically state the inclusion of the coverages and provisions set forth herein and shall state whether the coverage is "claims made" or "per occurrence".

B. COMMERCIAL GENERAL LIABILITY INSURANCE (CGL)

This insurance must protect the Contractor from all claims for bodily injury, including death and all claims for destruction of or damage to property (other than the Work itself), arising out of or in connection with any operations under this Contract, whether such operations be by the Contractor or by any Subcontractor under him or anyone directly or indirectly employed by the Contractor or by a Subcontractor. All such insurance shall be written with limits and coverages as specified below and shall be written on an occurrence form.

General Aggregate	$2,000,000
Products – Completed Operations Aggregate	$2,000,000
Each Occurrence	$1,000,000
Personal Injury	$1,000,000

The following coverages shall be included in the CGL:

1. Per project general aggregate (CG 25 03 or similar)
2. Additional Insured status in favor of the State of Colorado and any other parties as outlined in The Contract and must include both ONGOING Operations AND COMPLETED Operations per CG2010 10/01 and CG 2037 10/01 or equivalent as permitted by law.
3. The policy shall be endorsed to be **primary and non-contributory** with any insurance maintained by Additional Insureds.
4. A waiver of Subrogation in favor of all Additional Insured parties.
5. Personal Injury Liability
6. Contractual Liability coverage to support indemnification obligation per Article 53.I
7. Explosion, collapse and underground (xcu)

The following exclusionary endorsements are prohibited in the CGL policy:

1. Damage to Work performed by Subcontract/Vendor (CG 22-94 or similar)
2. Contractual Liability Coverage Exclusion modifying or deleting the definition of an “insured contract” from the unaltered SO CG 0001 1001 policy from (CG 24 26 or similar)
3. If applicable to the Work to be performed: Residential or multi-family
4. If applicable to the Work to be performed: Exterior insulation finish systems
5. If applicable to the Work to be performed: Subsidence or Earth Movement

The Contractor shall maintain general liability coverage including Products and Completed Operations insurance, and the Additional Insured with primary and non-contributory coverage as specified in this Contract for three (3) years after completion of the project.

C. AUTOMOBILE LIABILITY INSURANCE and business auto liability covering liability arising out of any auto (including owned, hired and non-owned autos).

Combined Bodily Injury and Property Damage Liability
(Combined Single Limit): $1,000,000 each accident

Coverages:
Specific waiver of subrogation

D. WORKERS' COMPENSATION INSURANCE

The Contractor shall procure and maintain Workers' Compensation Insurance at his or her own expense during the life of this Contract, including occupational disease provisions for all employees per statutory requirements. Policy shall contain a waiver of subrogation in favor of the State of Colorado.

The Contractor shall also require each Subcontractor to furnish Workers' Compensation Insurance, including occupational disease provisions for all of the latter’s employees, and to the extent not furnished, the Contractor accepts full liability and responsibility for Subcontractor’s employees.

In cases where any class of employees engaged in hazardous Work under this Contract at the site of the Project is not protected under the Workers' Compensation statute, the Contractor shall provide, and shall cause each Subcontractor to provide, adequate and suitable insurance for the protection of employees not otherwise protected.

E. UMBRELLA LIABILITY INSURANCE (for construction projects exceeding $10,000,000, provide the following coverage):
The Contractor shall maintain umbrella/excess liability insurance on an occurrence basis in excess of the underlying insurance described in Section B-D above. Coverage shall follow the terms of the underlying insurance, included the additional insured and waiver of subrogation provisions. The amounts of insurance required in Sections above may be satisfied by the Contractor purchasing coverage for the limits specified or by any combination of underlying and umbrella limits, so long as the total amount of insurance is not less than the limits specified in each section previously mentioned.

Each occurrence	$5,000,000
Aggregate	$5,000,000

F. BUILDER'S RISK INSURANCE
Unless otherwise expressly stated in the Supplementary General Conditions (e.g. where the State elects to provide for projects with a completed value of less than $1,000,000), the Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located, property insurance written on a builder's risk "all-risk" or equivalent policy form in the amount of the initial Contract Sum, plus value of subsequent Contract Modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis without optional deductibles. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made or until no person or entity other than the Owner has an insurable interest in the property, or the Date of Notice specified on the Notice of Acceptance, State Form SBP-6.27 or whichever is later.

This insurance shall include interests of the Owner, the Contractor, Subcontractors and Sub-subcontractors in the Project as named insureds.

All associated deductibles shall be the responsibility of the Contractor. Such policy may have a deductible clause but not to exceed ten thousand dollars ($10,000.00).

Property insurance shall be on an "all risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss or damage including, without duplication of coverage, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, false Work, testing and startup, temporary buildings and debris removal including demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Architect's and Contractor's services and expenses required as a result of such insured loss.

Contractor shall maintain Builders Risk coverage including partial use by Owner.
The Contractor shall waive all rights of subrogation as regards the State of Colorado and the Principal Representative, its officials, its officers, its agents and its employees, all while acting within the scope and course of their employment for damages caused by fire or other causes of loss to the extent covered by property insurance obtained pursuant to this Section or other property insurance applicable to the Work. The Contractor shall require all Subcontractors at any tier to similarly waive all such rights of subrogation and shall expressly include such a waiver in all subcontracts.

Upon request, the amount of such insurance shall be increased to include the cost of any additional Work to be done on the Project, or materials or equipment to be incorporated in the Project, under other independent contracts let or to be let. In such event, the Contractor shall be reimbursed for this cost as

his or her share of the insurance in the same ratio as the ratio of the insurance represented by such independent contracts let or to be let to the total insurance carried.

The Principal Representative, with approval of the State Controller, shall have the power to adjust and settle any loss. Unless it is agreed otherwise, all monies received shall be applied first on rebuilding or repairing the destroyed or injured Work.

G. POLLUTION LIABILITY INSURANCE

If Contractor is providing directly or indirectly Work with pollution/environmental hazards, the Contractor must provide or cause those conducting the Work to provide Pollution Liability Insurance coverage. Pollution Liability policy must include contractual liability coverage. State of Colorado must be included as additional insureds on the policy. The policy limits shall be in the amount of $1,000,000 with maximum deductible of $25,000 to be paid by the Subcontractor/Vendor.

H. ADDITIONAL MISCELLANEOUS INSURANCE PROVISIONS

Certificates of Insurance and/or insurance policies required under this Contract shall be subject to the following stipulations and additional requirements:

1. Any and all deductibles or self-insured retentions contained in any Insurance policy shall be assumed by and at the sole risk of the Contractor;
2. If any of the said policies shall fail at any time to meet the requirements of the Contract Documents as to form or substance, or if a company issuing any such policy shall be or at any time cease to be approved by the Division of Insurance of the State of Colorado, or be or cease to be in compliance with any stricter requirements of the Contract Documents, the Contractor shall promptly obtain a new policy, submit the same to the Principal Representative and State Building Programs for approval if requested, and submit a Certificate of Insurance as hereinbefore provided. Upon failure of the Contractor to furnish, deliver and maintain such insurance as provided herein, this Contract, in the sole discretion of the State of Colorado, may be immediately declared suspended, discontinued, or terminated. Failure of the Contractor in obtaining and/or maintaining any required insurance shall not relieve the Contractor from any liability under the Contract, nor shall the insurance requirements be construed to conflict with the obligations of the Contractor concerning indemnification;
3. All requisite insurance shall be obtained from financially responsible insurance companies, authorized to do business in the State of Colorado and acceptable to the Principal Representative;
4. Receipt, review or acceptance by the Principal Representative of any insurance policies or certificates of insurance required by this Contract shall not be construed as a waiver or relieve the Contractor from its obligation to meet the insurance requirements contained in these General Conditions.

ARTICLE 26. CONTRACTOR'S PERFORMANCE AND PAYMENT BONDS

The Contractor shall furnish a Performance Bond and a Labor and Material Payment Bond on State Forms SC-6.22, Performance Bond, and SC-6.221, Labor and Material Payment Bond, or such other forms as State Buildings Program may approve for the Project, executed by a corporate Surety authorized to do business in the State of Colorado and in the full amount of the Contract sum. The expense of these bonds shall be borne by the Contractor and the bonds shall be filed with State Buildings Program.

If, at any time, a Surety on such a bond is found to be, or ceases to be in strict compliance with any qualification requirements of the Contract Documents or the bid documents, or loses its right to do business in the State of Colorado, another Surety will be required, which the Contractor shall furnish to State Buildings Program within ten (10) days after receipt of Notice from the State or after the Contractor otherwise becomes aware of such conditions.

ARTICLE 27. LABOR AND WAGES

A. In accordance with laws of Colorado, C.R.S. § 8-17-101(1), as amended, Colorado labor shall be employed to perform at least eighty percent of the Work.

B. In accordance with laws of Colorado, C.R.S. § 24-92 Part 2, if prevailing wage rates are applicable to this project:

1. The contractor shall in conspicuous places on the project post an owner provided poster with the current prevailing rate of payments as provided in the project solicitation.

   a. A contractor who fails to comply shall be deemed guilty of a class 3 misdemeanor and shall pay the State one hundred dollars ($100) for each calendar day of noncompliance as determined by the State.

2. The contractor and any subcontractors shall pay all the employees employed directly on the site of the work, unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account, the full amounts accrued at time of payment computed at wage rates not less than those stated in the competitive solicitation, regardless of any contractual relationships that may be alleged to exist between the contractor or subcontractor and the employees.

3. The contractor and any subcontractors shall prepare and submit payroll reports to the State on a monthly basis that disclose all relevant payroll information, including the name and address of any entities to which fringe benefits are paid.

4. The contractor and any subcontractors shall maintain on the site where public projects are being constructed a daily log of employees employed each day on the public project. The log shall include, at a minimum, for each employee his or her name, primary job title, and employer, and shall be kept on a form prescribed by the director. The log shall be available for inspection on the site at all times by the State.

5. If the contractor or any subcontractor fails to pay wages as are required by the contract, the State shall not approve a warrant or demand for payment to the contractor until the contractor furnishes the State evidence satisfactory to such agency of government that such wages have been paid; except that the State shall approve and pay any portion of a warrant or demand for payment to the contractor to the extent the State has been furnished satisfactory evidence that the contractor or one or more subcontractors has paid such wages required by the contract, The contractor or subcontractor may use the following procedure in order to satisfy the requirements of this section:

   a. The contractor or subcontractor may submit to the State, for each employee to whom such wages are due, a check payable to that employee or to the State so it is negotiable by either party. Each such check shall be in an amount representing the difference between the accrued wages required to be paid to that employee by the contract and the wages actually paid by the contractor or subcontractor.

   b. If any check submitted cannot be delivered to the employee within a reasonable period, then it shall be negotiated by the State and the proceeds deposited in the unclaimed property trust fund created in section 38-13-116.6. Nothing in this subsection (1) shall be construed to lessen the responsibility of the contractor or subcontractor to attempt to locate and pay any employee to whom wages are due.

ARTICLE 28. ROYALTIES AND PATENTS

The Contractor shall be responsible for assuring that all rights to use of products and systems have been properly arranged and shall take such action as may be necessary to avoid delay, at no additional charge to the Principal Representative, where such right is challenged during the course of the Work. The Contractor shall pay all royalties and license fees required to be paid and shall defend all suits or claims for infringement of any patent rights and shall save the State of Colorado harmless from loss on account thereof, in accordance with Article 52C, Indemnification; provided, however, the Contractor shall not be responsible for such loss or

defense for any copyright violations contained in the Contract Documents prepared by the Architect/Engineer or the Principal Representative of which the Contractor is unaware, or for any patent violations based on specified processes that the Contractor is unaware are patented or that the Contractor should not have had reason to believe were patented.

ARTICLE 29. ASSIGNMENT

Except as otherwise provided hereafter the Contractor shall not assign the whole or any part of this Contract without the written consent of the Principal Representative. This provision shall not be construed to prohibit assignments of the right to payment to the extent permitted by C.R.S. § 4-9-406, et. seq., as amended, provided that written Notice of assignment adequate to identify the rights assigned is received by the Principal Representative and the controller for the agency, department, or institution executing this Contract (as distinguished from the State Controller). Such assignment of the right to payment shall not be deemed valid until receipt by the Principal Representative and such controller and the Contractor assumes the risk that such written Notice of assignment is received by the Principal Representative and the controller for the agency, department, or institution involved. In case the Contractor assigns all or part of any moneys due or to become due under this Contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in and to any moneys due or to become due to the Contractor shall be subject to all claims of all persons, firms, and corporations for services rendered or materials supplied for the performance of the Work called for in this Contract, whether said service or materials were supplied prior to or after the assignment. Nothing in this Article shall be deemed a waiver of any other defenses available to the State against the Contractor or the assignee.

ARTICLE 30. CORRECTION OF WORK BEFORE ACCEPTANCE

The Contractor shall promptly remove from the premises all Work or materials condemned or declared irreparably defective as failing to conform to the Contract Documents on receipt of written Notice from the Architect/Engineer or the Principal Representative, whether incorporated in the Work or not. If such materials shall have been incorporated in the Work, or if any unsatisfactory Work is discovered, the Contractor shall promptly replace and re-execute his or her Work in accordance with the requirements of the Contract Documents without expense to the Principal Representative, and shall also bear the expense of making good all Work of other contractors destroyed or damaged by the removal or replacement of such defective material or Work.

Should any defective Work or material be discovered during the process of construction, or should reasonable doubt arise as to whether certain material or Work is in accordance with the Contract Documents, the value of such defective or questionable material or Work shall not be included in any application for payment, or if previously included, shall be deducted by the Architect/Engineer from the next application submitted by the Contractor.

If the Contractor does not perform repair, correction and replacement of defective Work, in lieu of proceeding by issuance of a Notice of intent to remove condemned Work as outlined above, the Principal Representative may, not less than seven (7) days after giving the original written Notice of the need to repair, correct, or replace defective Work, deduct all costs and expenses of replacement or correction as instructed by the Architect/Engineer from the Contractor's next application for payment in addition to the value of the defective Work or material. The Principal Representative may also make an equitable deduction from the Contract sum by unilateral Change Order, in accordance with Article 33, Payments Withheld and Article 35, Changes In The Work.

If the Contractor does not remove such condemned or irreparably defective Work or material within a reasonable time, the Principal Representative may, after giving a second seven (7) day advance Notice to the Contractor and the Surety, remove them and may store the material at the Contractor's expense. The Principal Representative may accomplish the removal and replacement with its own forces or with another Contractor. If the Contractor does not pay the expense of such removal and pay all storage charges within ten (10) days thereafter, the Principal Representative may, upon ten (10) days' written Notice, sell such material at auction or at private sale and account for the net proceeds thereof, after deducting all costs and expenses which should have been borne by the Contractor. If the Contractor shall commence and diligently pursue such removal and replacement before the expiration of the seven-day period, or if the Contractor shall show good

cause in conjunction with submittal of a revised CPM schedule showing when the Work will be performed and why such removal of condemned Work should be scheduled for a later date, the Principal Representative shall not proceed to remove or replace the condemned Work.

If the Contractor disagrees with the Notice to remove Work or materials condemned or declared irreparably defective, the Contractor may request facilitated negotiation of the issue and the Principal Representative's right to proceed with removal and to deduct costs and expenses of repair shall be suspended and tolled until such time as the parties meet and negotiate the issue

During construction, whenever the Architect/Engineer has advised the Contractor in writing, in the Specifications, by reference to Article 6, Architect/Engineer Decisions and Judgments, of these General Conditions or elsewhere in the Contract Documents of a need to observe materials in place prior to their being permanently covered up, it shall be the Contractor's responsibility to notify the Architect/Engineer at least forty-eight (48) hours in advance of such covering operation. If the Contractor fails to provide such notification, Contractor shall, at his or her expense, uncover such portions of the Work as required by the Architect/Engineer for observation, and reinstall such covering after observation. When a covering operation is continued from day to day, notification of the commencement of a single continuing covering operation shall suffice for the activity specified so long as it proceeds regularly and without interruption from day to day, in which event the Contractor shall coordinate with the Architect/Engineer regarding the continuing covering operation.

ARTICLE 31. APPLICATIONS FOR PAYMENTS

A. CONTRACTOR'S SUBMITTALS

On or before the first day of each month and no more than five days prior thereto, the Contractor may submit applications for payment for the Work performed during such month covering the portion of the Work completed as of the date indicated, and payments on account of this Contract shall be due per C.R.S. § 24-30-202(24) (correct notice of amount due), within forty-five (45) days of receipt by the Principal Representative of application for payments that have been certified by the Architect/Engineer. The Contractor shall submit the application for payment to the Architect/Engineer on State forms SBP-7.2, Certificate for Contractor's Payment, or such other format as the State Buildings Program shall approve, in an itemized format in accordance with the schedule of values or a cost loaded CPM schedule when required, supported to the extent reasonably required by the Architect/Engineer or the Principal Representative by receipts or other vouchers, showing payments for materials and labor, prior payments and payments to be made to Subcontractors and such other evidence of the Contractor's right to payments as the Architect/Engineer or Principal Representative may direct.

If payments are made on account of materials not incorporated in the Work but delivered and suitably stored at the site, or at some other location agreed upon in writing, such payments shall be conditioned upon submission by the Contractor of bills of sale or such other procedure as will establish the Principal Representative's title to such material or otherwise adequately protect the Principal Representative's interests, and shall provide proof of insurance whenever requested by the Principal Representative or the Architect/Engineer, and shall be subject to the right to inspect the materials at the request of either the Architect/Engineer or the Principal Representative.

All applications for payment, except the final application, and the payments there under, shall be subject to correction in the next application rendered following the discovery of any error.

B. ARCHITECT/ENGINEER CERTIFICATION

In accordance with the Architect/Engineer's agreement with the Principal Representative, the Architect/Engineer after appropriate observation of the progress of the Work shall certify to the Principal Representative the amount that the Contractor is entitled to, and forward the application to the Principal Representative. If the Architect/Engineer certifies an amount different from the amount requested or otherwise alters the Contractor's application for payment, a copy shall be forwarded to the Contractor.

If the Architect/Engineer is unable to certify all or portions of the amount requested due to the absence or lack of required supporting evidence, the Architect/Engineer shall advise the Contractor of the

deficiency. If the deficiency is not corrected at the end of ten (10) days, the Architect/Engineer may either certify the remaining amounts properly supported to which the Contractor is entitled, or return the application for payment to the Contractor for revision with a written explanation as to why it could not be certified.

C. RETAINAGE WITHHELD

Unless otherwise provided in the Supplementary General Conditions, an amount equivalent to five percent (5%) of the amount shown to be due the Contractor on each application for payment shall be withheld until the Work required by the Contract has been performed. The withheld percentage of the contract price of any such Work, improvement, or construction shall be administered according to C.R.S. § 24-91-103, as amended, and C.R.S. § 38-26-107, as amended, and Article 31D, shall be retained until the Work or discrete portions of the Work, have been completed satisfactorily, finally or partially accepted, and advertised for final settlement as further provided in Article 41.

D. RELEASE OF RETAINAGE

The Contractor may, for satisfactory and substantial reasons shown to the Principal Representative's satisfaction, make a written request to the Principal Representative and the Architect/Engineer for release of part or all of the withheld percentage applicable to the Work of a Subcontractor which has completed the subcontracted Work in a manner finally acceptable to the Architect/Engineer, the Contractor, and the Principal Representative. Any such request shall be supported by a written approval from the Surety furnishing the Contractor's bonds and any surety that has provided a bond for the Subcontractor. The release of any such withheld percentage shall be further supported by such other evidence as the Architect/Engineer or the Principal Representative may require, including but not limited to, evidence of prior payments made to the Subcontractor, copies of the Subcontractor's contract with the Contractor, any applicable warranties, as-built information, maintenance manuals and other customary close-out documentation. Neither the Principal Representative nor the Architect Engineer shall be obligated to review such documentation nor shall they be deemed to assume any obligations to third parties by any review undertaken.

The Contractor's obligation under these General Conditions to guarantee Work for one year from the date of the Notice of Substantial Completion or the date of any Notice of Partial Substantial Completion of the applicable portion or phase of the Project, shall be unaffected by such partial release; unless a Notice of Partial Substantial Completion is issued for the Work subject to the release of retainage.

Any rights of the Principal Representative which might be terminated by or from the date of any final acceptance of the Work, whether at common law or by the terms of this Contract, shall not be affected by such partial release of retainage prior to any final acceptance of the entire Project.

The Contractor remains fully responsible for the Subcontractor's Work and assumes any risk that might arise by virtue of the partial release to the Subcontractor of the withheld percentage, including the risk that the Subcontractor may not have fully paid for all materials, labor and equipment furnished to the Project.

If the Principal Representative considers the Contractor's request for such release satisfactory and supported by substantial reasons, the Architect/Engineer shall make a "final inspection" of the applicable portion of the Project to determine whether the Subcontractor 's Work has been completed in accordance with the Contract Documents. A final punch list shall be made for the Subcontractor's Work and the procedures of Article 41, Completion, Final Inspection, Acceptance and Settlement, shall be followed for that portion of the Work, except that advertisement of the intent to make final payment to the Subcontractor shall be required only if the Principal Representative has reason to believe that a supplier or Subcontractor to the Subcontractor for which the request is made, may not have been fully paid for all labor and materials furnished to the Project.

ARTICLE 32. CERTIFICATES FOR PAYMENTS

State Form SBP-7.2, Certificate For Contractor's Payment, and its continuation detail sheets, when submitted, shall constitute the Certificate of Contractor's Application for Payment, and shall be a representation by the

Contractor to the Principal Representative that the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and materials for which payment is requested have been incorporated into the Project except as noted in the application. If requested by the Principal Representative the Certificate of Contractor's Application for Payment shall be sworn under oath and notarized.

ARTICLE 33. PAYMENTS WITHHELD

The Architect/Engineer, the Principal Representative or State Buildings Program may withhold, or on account of subsequently discovered evidence nullify, the whole or any part of any application on account of, but not limited to any of the following:

1. Defective Work not remedied;
2. Claims filed or reasonable evidence indicating probable filing of claims;
3. Failure of the Contractor to make payments to Subcontractors for material or labor;
4. A reasonable doubt that the Contract can be completed for the balance of the contract price then unpaid;
5. Damage or injury to another contractor or any other person, persons or property except to the extent of coverage by a policy of insurance;
6. Failure to obtain necessary permits or licenses or to comply with applicable laws, ordinances, codes, rules or regulations or the directions of the Architect/Engineer;
7. Failure to submit a monthly construction schedule;
8. Failure of the Contractor to keep Work progressing in accordance with the time schedule;
9. Failure to keep a superintendent on the Work;
10. Failure to maintain as built drawings of the Work in progress;
11. Unauthorized deviations by the Contractor from the Contract Documents; or
12. On account of liquidated damages.

In addition, the Architect Engineer, Principal Representative or State Buildings Program may withhold or nullify the whole or any part of any application for any reason noted elsewhere in these General Conditions of the Contractor's Design/Bid/Build Agreement. Nullification shall mean reduction of amounts shown as previously paid on the application. The amount withheld or nullified may be in such amount as the Architect/Engineer or the Principal Representative estimates to be required to allow the State to accomplish the Work, cure the failure and cover any damages or injuries, including an allowance for attorneys' fees and costs where appropriate. When the grounds for such withholding or nullifying are removed, payment shall be made for the amounts thus withheld or nullified on such grounds.

ARTICLE 34. DEDUCTIONS FOR UNCORRECTED WORK

If the Architect/Engineer and the Principal Representative deem it inexpedient to correct Work damaged or not performed in accordance with the Contract Documents, the Principal Representative may, after consultation with the Architect/Engineer and ten (10) days' Notice to the Contractor of intent to do so, make reasonable reductions from the amounts otherwise due the Contractor on the next application for payment. Notice shall specify the amount or terms of any contemplated reduction. The Contractor may during this period correct or perform the Work. If the Contractor does not correct or perform the Work, an equitable deduction from the Contract sum shall be made by Change Order, in accordance with Article 35, Changes in The Work, unilaterally if necessary. If either party elects' facilitation of this issue after Notice is given, the ten-day (10) notice period shall be extended and tolled until facilitation has occurred.

ARTICLE 35. CHANGES IN THE WORK

The Principal Representative may designate, without invalidating the Agreement, and with the approval of State Buildings Program and the State Controller, may order extra Work or make changes with or without the consent of the Contractor as hereafter provided, by altering, adding to or deducting from the Work, the Contract sum being adjusted accordingly. All such changes in the Work shall be within the general scope of and be executed under the conditions of the Contract, except that any claim for extension of time made necessary due to the change or any claim of other delay or other impacts caused by or resulting from the change in the Work shall be presented by the Contractor and adjusted by Change Order to the extent known at the time such change is ordered and before proceeding with the extra or changed Work. Any claims for extension of

time or of delay or other impacts, and any costs associated with extension of time, delay or other impacts, which are not presented before proceeding with the change in the Work, and which are not adjusted by Change Order to the extent known, shall be waived.

The Architect/Engineer shall have authority to make minor changes in the Work, not involving extra cost, and not inconsistent with the intent of the Contract Documents, but otherwise, except in an emergency endangering life or property, no extra Work or change in the Contract Documents shall be made unless by 1) a written Change Order, approved by the Principal Representative, State Buildings Program, and the State Controller prior to proceeding with the changed Work; or 2) by an Emergency Field Change Order approved by the Principal Representative and State Buildings Program as hereafter provided in Article 35C, Emergency Field Ordered Changed Work; or 3) by an allocation in writing of any allowance already provided in the encumbered contract amount, the Contract sum being later adjusted to decrease the Contract sum by any unallocated or unexpended amounts remaining in such allowance. No change to the Contract sum shall be valid unless so ordered.

A. THE VALUE OF CHANGED WORK

1. The value of any extra Work or changes in the Work shall be determined by agreement in one or more of the following ways:
   a. By estimate and acceptance of a lump-sum amount;
   b. By unit prices specified in the Agreement, or subsequently agreed upon, that are extended by specific quantities;
   c. By actual cost plus a fixed fee in a lump sum amount for profit, overhead and all indirect and off-site home office costs, the latter amount agreed upon in writing prior to starting the extra or changed Work.
2. Where the Contractor and the Principal Representative cannot agree on the value of extra Work, the Principal Representative may order the Contractor to perform the changes in the Work and a Change Order may be unilaterally issued based on an estimate of the change in the Work prepared by the Architect/Engineer. The value of the change in the Work shall be the Principal Representative's determination of the amount of equitable adjustment attributable to the extra Work or change. The Principal Representative's determination shall be subject to appeal by the Contractor pursuant to the claims process in Article 36, Claims.
3. Except as otherwise provided in Article 35B, Detailed Breakdown, the Cost Principles of the Colorado Procurement Code or the applicable procurement code for institutions of higher education, shall govern all Contract changes.

B. DETAILED BREAKDOWN

In all cases where the value of the extra or changed Work is not known based on unit prices in the Contractor's bid or the Agreement, a detailed change proposal shall be submitted by the Contractor on a Change Order Proposal (SC-6.312), or in such other format as the State Buildings Program approves, with which the Principal Representative may require an itemized list of materials, equipment and labor, indicating quantities, time and cost for completion of the changed Work.

Such detailed change proposals shall be stated in lump sum amounts and shall be supported by a separate breakdown, which shall include estimates of all or part of the following when requested by the Architect/Engineer or the Principal Representative:

1. Materials, indicating quantities and unit prices including taxes and delivery costs if any (separated where appropriate into general, mechanical and electrical and/or other Subcontractors' Work; and the Principal Representative may require in its discretion any significant subcontract costs to be similarly and separately broken down).
2. Labor costs, indicating hourly rates and time and labor burden to include Social Security and other payroll taxes such as unemployment, benefits and other customary burdens.

3. Costs of project management time and superintendence time of personnel stationed at the site, and other field supervision time, but only where a time extension, other than a weather delay, is approved as part of the Change Order, and only where such project management time and superintendence time is directly attributable to and required by the change; provided however that additional cost of on-site superintendence shall be allowable whenever in the opinion of the Architect/Engineer the impact of multiple change requests to be concurrently performed will result in inadequate levels of supervision to assure a proper result unless additional superintendence is provided.
4. Construction equipment (including small tools). Expenses for equipment and fuel shall be based on customary commercially reasonable rental rates and schedules. Equipment and hand tool costs shall not include the cost of items customarily owned by workers.
5. Workers' compensation costs, if not included in labor burden.
6. The cost of commercial general liability and property damage insurance premiums but only to the extent charged the Contractor as a result of the changed Work.
7. Overhead and profit, as hereafter specified.
8. Builder's risk insurance premium costs.
9. Bond premium costs.
10. Testing costs not otherwise excluded by these General Conditions.
11. Subcontract costs.

Unless modified in the Supplementary General Conditions, overhead and profit shall not exceed the percentages set forth in the table below.

	OVERHEAD	PROFIT	COMMISSION
To the Contractor or to Subcontractors for the portion of Work performed with their own forces:	10%	5%	0%
To the Contractor or to Subcontractors for Work performed by others at a tier immediately below either of them:	5%	0%	5%

Overhead shall include: a) insurance premium for policies not purchased for the Project and itemized above, b) home office costs for office management, administrative and supervisory personnel and assistants, c) estimating and change order preparation costs, d) incidental job burdens, e) legal costs, f) data processing costs, g) interest costs on capital, h) general office expenses except those attributable to increased rental expenses for temporary facilities, and all other indirect costs, but shall not include the Social Security tax and other direct labor burdens. The term "Work" as used in the proceeding table shall include labor, materials and equipment and the "Commission" shall include all costs and profit for carrying the subcontracted Work at the tiers below except direct costs as listed in items 1 through 11 above if any.

On proposals for Work involving both additions and credits in the amount of the Contract sum, the overhead and profit will be allowed on the net increase only. On proposals resulting in a net deduct to the amount of the Contract sum, profit on the deducted amount shall be returned to the Principal Representative at fifty percent (50%) of the rate specified. The inadequacy of the profit specified shall not be a basis for refusal to submit a proposal.

Except in the case of Change Orders or Emergency Field Change Orders agreed to on the basis of a lump sum amount or unit prices as described in paragraphs 35A1 and 35A2 above, The Value of Changed Work, the Contractor shall keep and present a correct and fully auditable account of the several items of cost, together with vouchers, receipts, time cards and other proof of costs incurred, summarized on a Change Order form (SC-6.31) using such format for supporting documentation as the Principal Representative and State Buildings Program approve. This requirement applies equally to Work done by Subcontractors. Only auditable costs shall be reimbursable on Change Orders where the value is determined on the basis of actual cost plus a fixed fee pursuant to paragraph 35A3 above,

or where unilaterally determined by the Principal Representative on the basis of an equitable adjustment in accordance with the Procurement Rules, as described above in Article 35A, The Value Of Changed Work.

Except for proposals for Work involving both additions and credits, changed Work shall be adjusted and considered separately for Work either added or omitted. The amount of adjustment for Work omitted shall be estimated at the time it is directed to be omitted, and when reasonable to do so, the agreed adjustment shall be reflected on the schedule of values used for the next Contractor's application for payment.

The Principal Representative reserves the right to contract with any person or firm other than the Contractor for any or all extra Work; however, unless specifically required in the Contract Documents, the Contractor shall have no responsibility without additional compensation to supervise or coordinate the Work of persons or firms separately contracted by the Principal Representative.

C. HAZARDOUS MATERIALS

1. The Principal Representative represents that it has undertaken an examination of the site of the Work and has determined that there are no hazardous substances, as defined below, which the Contractor could reasonably encounter in its performance of the Work. In the event the Principal Representative so discovers hazardous substances, the Principal Representative shall render harmless such hazards before the Contractor commences the Work.

2. In the event the Contractor encounters any materials reasonably believed to be hazardous substances which have not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Principal Representative, in writing. For purposes of this Agreement, "hazardous substances" shall include asbestos, lead, polychlorinated biphenyl (PCB) and any or all of those substances defined as "hazardous substance", "hazardous waste", or "dangerous or extremely hazardous wastes" as those terms are used in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA), and shall also include materials regulated by the Toxic Substances Control Act (TSCA), the Clean Air Act, the Air Quality Act, the Clean Water Act, and the Occupational Safety and Health Act. The Work in the affected area shall not therefore be resumed except by written agreement of the Principal Representative and the Contractor, if in fact materials that are hazardous substances have not been rendered harmless. The Work in the affected area shall be resumed only in the absence of the hazardous substances or when it has been rendered harmless or by written agreement of the Principal Representative and the Contractor.

3. The contractor shall not be required to perform Work without consent in any areas where it reasonably believes hazardous substances that have not been rendered harmless are present.

D. EMERGENCY FIELD CHANGE ORDERED WORK

The Principal Representative, without invalidating the Agreement, and with the approval of State Buildings Program and without the approval of the State Controller, may order extra Work or make changes in the case of an emergency that is a threat to life or property or where the likelihood of delays in processing a normal Change Order will result in substantial delays and or significant cost increases for the Project. Emergency Field Orders are not to be used solely to expedite normal Change Order processing absent a clear showing of a high potential for significant and substantial cost or delay. Such changes in the Work may be directed through issuance of an Emergency Field Change Order signed by the Contractor, the Principal Representative (or by a designee specifically appointed to do so in writing), and approved by the Director of State Buildings Program or his or her delegate. The change shall be directed using an Emergency Field Change Order form (SC-6.31E).

If the amount of the adjustment of the Contract price and time for completion can be determined at the time of issuance of the Emergency Field Change Order, those adjustments shall be reflected on the face of the Emergency Field Change Order. Otherwise, the Emergency Field Change Order shall reflect a not to exceed (NTE) amount for any schedule adjustment (increasing or decreasing the time for completion) and an NTE amount for any adjustment to Contract sum, which NTE amount shall represent the maximum amount of adjustment to which the Contractor will be entitled, including direct and indirect costs of changed Work, as well as any direct or indirect costs attributable to delays, inefficiencies or other impacts arising out of the change. Emergency Field Change Orders directed in accordance with this provision need not bear the approval signatures of the State Controller.

On Emergency Field Change Orders where the price and schedule have not been finally determined, the Contractor shall submit final costs for adjustment as soon as practicable. No later than seven (7) days after issuance, except as otherwise permitted, and every seven days thereafter, the Contractor shall report all costs to the Principal Representative and the Architect/Engineer. The final adjustment of the Emergency Field Change Order amount and the adjustment to the Project time for completion shall be prepared on a normal Change Order from (SC-6.31) in accordance with the procedures described in Article 35A, The Value of Changed Work, and B, Detailed Breakdown, above. Unless otherwise provided in writing signed by the Director of State Buildings Program to the Principal Representative and the Contractor, describing the extent and limits of any greater authority, individual Emergency Field Change Orders shall not be issued for more than $25,000, nor shall the cumulative value of Emergency Field Change Orders exceed an amount of $100,000.

E. APPROPRIATION LIMITATIONS - C.R.S. § 24-91-103.6, as amended

The amount of money appropriated, as shown on the Contractor's Design/Bid/Build Agreement (SC 6.21), is equal to or in excess of the Contract amount. No Change Order, Emergency Field Change Order, or other type of order or directive shall be issued by the Principal Representative, or any agent acting on his or her behalf, which directs additional compensable Work to be performed, which Work causes the aggregate amount payable under the Contract to exceed the amount appropriated for the original Contract, as shown on the Agreement (SC-6.21), unless one of the following occurs: (1) the Contractor is provided written assurance from the Principal Representative that sufficient additional lawful appropriations exist to cover the cost of the additional Work; or (2) the Work is covered by a contractor remedy provision under the Contract, such as a claim for extra cost. By way of example only, no assurance is required for any order, directive or instruction by the Architect/Engineer or the Principal Representative to perform Work which is determined to be within the performance required by the Contract Documents; the Contractor's remedy shall be as described elsewhere in these General Conditions.

Written assurance shall be in the form of an Amendment to the Contract reciting the source and amount of such appropriation available for the Project. No remedy granting provision of this Contract shall obligate the Principal Representative to seek appropriations to cover costs in excess of the amounts recited as available to pay for the Work to be performed.

ARTICLE 36. CLAIMS

It is the intent of these General Conditions to provide procedures for speedy and timely resolution of disagreements and disputes at the lowest level possible. In the spirit of on the job resolution of job site issues, the parties are encouraged to use the partnering processes of Article 2D, Partnering, Communications and Cooperation, before turning to the more formal claims processes described in this Article 36, Claims. The use of non-binding dispute resolution, whether through the formal processes described in Article 39, Non-Binding Dispute Resolution – Facilitated Negotiations, or through less formal alternative processes developed as part of a partnering plan, are also encouraged. Where such process cannot resolve the issues in dispute, the claims process that follows is intended to cause the issues to be presented, decided and where necessary, documented in close proximity to the events from which the issues arise. To that end, and in summary of the remedy granting process that follows commencing with the next paragraph of this Article 36, Claims, the Contractor shall 1) first, seek a decision by the Architect/Engineer, and 2) shall second, informally present the claim to Principal Representative as described hereafter, and 3) failing resolution in the field, give Notice of intent to exercise statutory rights of review of a formal contract controversy, and 4) seek resolution outside the

Contract as provided by the Colorado Procurement Code or the applicable procurement code for institutions of higher education.

If the Contractor claims that any instructions, by detailed drawings, or otherwise, or any other act or omission of the Architect/Engineer or Principal Representative affecting the scope of the Contractor's Work, involve extra cost, extra time or changes in the scope of the Work under this Contract, the Contractor shall have the right to assert a claim for such costs or time, provided that before either proceeding to execute such Work (except in an emergency endangering life or property), or filing a Notice of claim, the Contractor shall have obtained or requested a written decision of the Architect/Engineer following the procedures as provided in Article 6A and B, Architect/Engineer Decisions and Judgments, respectively; provided, however, that in the case of a directed change in the Work pursuant to Article 35, no written judgment or decision of the Architect/Engineer is required. If the Contractor is delayed by the lack of a response to a request for a decision by the Architect/Engineer, the Contractor shall give Notice in accordance with Article 38, Delays and Extensions of Time.

Unless it is the Architect/Engineer's judgment and determination that the Work is not included in the performance required by the Contract Documents, the Contractor shall proceed with the Work as originally directed. Where the Contractor's claim involves a dispute concerning the value of Work unilaterally directed pursuant to Article 35.A.2 the Contractor shall also proceed with the Work as originally directed while his or her claim is being considered.

The Contractor shall give the Principal Representative and the Architect/Engineer Notice of any claim promptly after the receipt of the Architect/Engineer's decision, but in no case later than three (3) business days after receipt of the Architect/Engineer's decision (or no later than ten (10) days from the date of the Contractor's request for a decision when the Architect/Engineer fails to decide as provided in Article 6). The Notice of claim shall state the grounds for the claim and the amount of the claim to the extent known in accordance with the procedures of Article 35, Changes in the Work. The period in which Notice must be given may be extended by the Principal Representative if requested in writing by the Contractor with good cause shown, but any such extension to be effective shall be in writing.

The Principal Representative shall respond in writing, with a copy to the Architect/Engineer, within a reasonable time, and except where a request for facilitation of negotiation has been made as hereafter provided, in no case later than seven (7) business days (or at such other time as the Contractor and Principal Representative agree) after receipt of the Contractor's Notice of claim regarding such instructions or alleged act or omission. If no response to the Contractor's claim is received within seven (7) business days of Contractor's Notice (or at such other time as the Contractor and Principal Representative agree) and the instructions have not been retracted, it shall be deemed that the Principal Representative has denied the claim.

The Principal Representative may grant or deny the claim in whole or in part, and a Change Order shall be issued if the claim is granted. To the extent any portion of claim is granted where costs are not clearly shown, the Principal Representative may direct that the value of that portion of the Work be determined by any method allowed in Article 35A, The Value of Changed Work. Except in the case of a deemed denial, the Principal Representative shall provide a written explanation regarding any portion of the Contractor's claim that is denied.

If the Contractor disagrees with the Principal Representative's judgment and determination on the claim and seeks an equitable adjustment of the Contract sum or time for performance, he or she shall give Notice of intent to exercise his or her statutory right to seek a decision on the contract controversy within ten (10) days of receipt of the Principal Representative's decision denying the claim. A "contract controversy," as such term is used in the Colorado Procurement Code or the applicable procurement code for institutions of higher education, shall not arise until the initial claim process described above in this Article 36 has been properly exhausted by the Contractor. The Contractor's failure to proceed with Work directed by the Architect/Engineer or to exhaust the claim process provided above in this Article 36, shall constitute an abandonment of the claim by the Contractor and a waiver of the right to contest the decision in any forum.

At the time of filing the Notice of intent to exercise his or her statutory right to seek a decision on the contract controversy, the Contractor may request that the Principal Representative defer a decision on the contract controversy until a later date or until the end of the Project. If the Principal Representative agrees, he or she shall so advise the Contractor in writing. If no such request is made, or if the Principal Representative does not agree to such a request, the Principal Representative shall render a written decision within twenty (20) business days and advise the Contractor of the reasons for any denial. Unless the claim has been decided by the Principal Representative (as opposed to delegates of the Principal Representative), the person who renders the decision on this statutory contract controversy shall not be the same person who decided the claim. To the extent any portion of the contract controversy is granted where costs are not clearly shown, the Principal Representative may direct that the value of that portion of the Work be determined by any method allowed in Article 35A, The Value of Changed Work. In the event of a denial the Principal Representative shall give Notice to the Contractor of his or her right to administrative and judicial reviews as provided in the Colorado Procurement Code or the applicable procurement code for institutions of higher education. If no decision regarding the contract controversy is issued within twenty (20) business days of the Contractor's giving Notice (or such other date as the Contractor and Principal Representative have agreed), and the instructions have not been retracted or the alleged act or omission have not been corrected, it shall be deemed that the Principal Representative has ruled by denial on the contract controversy. Except in the case of a deemed denial, the Principal Representative shall provide an explanation regarding any portion of the contract controversy that involves denial of the Contractor's claim.

Either the Contractor or the Principal Representative may request facilitation of negotiations concerning the claim or the contract controversy, and if requested, the parties shall consult and negotiate before the Principal Representative decides the issue. Any request for facilitation by the Contractor shall be made at the time of the giving of Notice of the claim or Notice of the contract controversy. Facilitation shall extend the time for the Principal Representative to respond by commencing the applicable period at the completion of the facilitated negotiation, which shall be the last day of the parties' meeting, unless otherwise agreed in writing.

Disagreement with the decision of the Architect Engineer, or the decision of the Principal Representative to deny any claim or denying the contract controversy, shall not be grounds for the Contractor to refuse to perform the Work directed or to suspend or terminate performance. During the period that any claim or contract controversy decision is pending under this Article 36, Claims, the Contractor shall proceed diligently with the Work directed.
In all cases where the Contractor proceeds with the Work and seeks equitable adjustment by filing a claim and or statutory appeal, the Contractor shall keep a correct account of the extra cost, in accordance with Article 35B, Detailed Breakdown supported by receipts. The Principal Representative shall be entitled to reject any claim or contract controversy whenever the foregoing procedures are not followed and such accounts and receipts are not presented.

The payments to the Contractor in respect of such extra costs shall be limited to reimbursement for the current additional expenditure by the Contractor made necessary by the change in the Work, plus a reasonable amount for overhead and profit, determined in accordance with Article 35B, Detailed Breakdown, determined solely with reference to the additional Work, if any, required by the change.

ARTICLE 37. DIFFERING SITE CONDITIONS

A. NOTICE IN WRITING

The Contractor shall promptly, and where possible before conditions are disturbed, give the Architect/Engineer and the Principal Representative Notice in writing of:

1. subsurface or latent physical conditions at the site differing materially from those indicated in or reasonably assumed from the information provided in the Contract Documents; and,
2. unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in Work of the character provided for in the Contract Documents.

The Architect/Engineer shall promptly investigate the conditions, and if it is found that such conditions do materially so differ and cause an increase or decrease in the Contractor 's costs of performance of

any part of the Work required by the Contract Documents, whether or not such Work is changed as a result of such conditions, an equitable adjustment shall be made and the Contract sum shall be modified in accordance with Article 35, Changes in the Work.

If the time required for completion of the Work affected by such materially differing conditions will extend the Work on the critical path as indicated on the CPM schedule, the time for completion shall also be equitably adjusted.

B. LIMITATIONS

No claim of the Contractor under this clause shall be allowed unless the Contractor has given the Notice required in Article 37A, Notice in Writing, above. The time prescribed for presentation and adjustment in Articles 36, Claims and 38, Delays and Extensions of Time, shall be reasonably extended by the State to the extent required by the nature of the differing conditions; provided, however, that even when so extended no claim by the Contractor for an equitable adjustment hereunder shall be allowed if not quantified and presented prior to the date the Contractor requests a final inspection pursuant to Article 41A, Notice Of Completion.

ARTICLE 38. DELAYS AND EXTENSIONS OF TIME

If the Contractor is delayed at any time in the progress of the Work by any act or neglect of the State of Colorado or the Architect/Engineer, or of any employee or agent of either, or by any separately employed Contractor or by strikes, lockouts, fire, unusual delay in transportation, unavoidable casualties or any other causes beyond the Contractor's control, including weather delays as defined below, the time of Completion of the Work shall be extended for a period equal to such portion of the period of delays directly affecting the completion of the Work as the Contractor shall be able to show he or she could not have avoided by the exercise of due diligence.

The Contractor shall provide Notice in writing to the Architect/Engineer, the Principal Representative and State Buildings Program within three (3) business days from the beginning of such delay and shall file a written claim for an extension of time within seven (7) business days after the period of such delay has ceased, otherwise, any claim for an extension of time is waived.

Provided that the Contractor has submitted reasonable schedules for approval when required by Article 12, Requests for Information and Schedules, if no schedule is agreed to fixing the dates on which the responses to requests for information or detail drawings will be needed, or Shop Drawings, Product Data or Samples are to be reviewed as required or allowed by Article 12B, Schedules, no extension of time will be allowed for the Architect/ Engineer's failure to furnish such detail drawings as needed, or for the failure to initially review Shop Drawings, Product Data or Samples, except in respect of that part of any delay in furnishing detail drawings or instructions extending beyond a reasonable period after written demand for such detailed drawings or instructions is received by the Architect/Engineer. In any event, any claim for an extension of time for such cause will be recognized only to the extent of delay directly caused by failure to furnish detail drawings or instructions or to review Shop Drawings, Product Data or Samples pursuant to schedule, after such demand.

All claims for extension of time due to a delay claimed to arise or result from ordered changes in the scope of the Work, or due to instructions claimed to increase the scope of the Work, shall be presented to the Architect/Engineer, the Principal Representative and State Buildings Program as part of a claim for extra cost, if any, in accordance with Article 36, Claims, and in accordance with the Change Order procedures required by Article 35, Changes in The Work.

Except as otherwise provided in this paragraph, no extension of time shall be granted when the Contractor has failed to utilize a CPM schedule or otherwise identify the Project's critical path as specified in Article 12, Requests for Information and Schedules, or has elected not to do so when allowed by the Supplementary General Conditions or the Specifications to use less sophisticated scheduling tools, or has failed to maintain such a schedule. Delay directly affecting the completion of the Work shall result in an extension of time only to the extent that completion of the Work was affected by impacts to the critical path shown on Contractor's CPM schedule. Where the circumstances make it indisputable in the opinion of the Architect/Engineer that

the delay affected the completion of the Work so directly that the additional notice of the schedule impact by reference to a CPM schedule was unnecessary, a reasonable extension of time may be granted.

Extension of the time for completion of the Work will be granted for delays due to weather conditions only when the Contractor demonstrates that such conditions were more severe and extended than those reflected by the ten-year average for the month, as evidenced by the Climatological Data, U. S. Department of Commerce, for the Project area.

Extensions of the time for completion of the Work due to weather will be granted on the basis of one and three tenths (1.3) calendar days for every day that the Contractor would have Worked but was unable to Work, with each separate extension figured to the nearest whole calendar day.

For weather delays and delays caused by events, acts or omissions not within the control of the Principal Representative or any person acting on the Principal Representative's behalf, the Contractor shall be entitled to an extension of time only and shall not be entitled to recovery of additional cost due to or resulting from such delays. This Article does not, however, preclude the recovery of damages for delay by either party under other provisions in the Contract Documents.

ARTICLE 39. NON-BINDING DISPUTE RESOLUTION – FACILITATED NEGOTIATIONS

The Contractor and Principal Representative agree to designate one or more mutually acceptable persons willing and able to facilitate negotiations and communications for the resolution of conflicts, disagreements or disputes between them at the specific request of either party with regard to any Project decision of either of them or any decision of the Architect/Engineer. The designation of such person(s) shall not carry any obligation to use their services except that each party agrees that if the other party requests the intervention of such person(s) with respect to any such conflict, dispute or disagreement, the non-requesting party shall participate in good faith attempts to negotiate a resolution of the issue in dispute. If the parties cannot agree on a mutually acceptable person to serve in this capacity one shall be so appointed; provided, however, that either party may request the director of State Buildings Program to appoint such a person, who, if appointed, shall be accepted for this purpose by both the Contractor and the Principal Representative.

The cost, if any, of the facilitative services of the person(s) so designated shall be shared if the parties so agree in any partnering plan; or in the absence of agreement the cost shall be borne by the party requesting the facilitation of negotiation.

Any dispute, claim, question or disagreement arising from or relating to the Contract or an alleged breach of the Contract may be subject to a request by either party for facilitated negotiation subject to the limitations hereafter listed, and the parties shall participate by consultation and negotiation with each other, as guided by the facilitator and with recognition of their mutual interests, in an attempt to reach an equitable solution satisfactory to both parties.

The obligation to participate in facilitated negotiations shall be as described above and elsewhere in these General Conditions, as by way of example in Article 36, Claims, or Article 34, Deductions for Uncorrected Work and to the extent not more particularly described or limited elsewhere, each party's obligations shall be as follows:

1. a party shall not initiate communication with the facilitator regarding the issues in dispute; except that any request for facilitation shall be made in writing with copies sent, faxed or delivered to the other party;
2. a party shall prepare a brief written description of its position if so requested by the facilitator (who may elect to first discuss the parties' positions with each party separately in the interest of time and expense);
3. a party shall respond to any reasonable request for copies of documents requested by the facilitator, but such requests, if voluminous, may consist of an offer to allow the facilitator access to the parties' documents;
4. a party shall review any meeting agenda proposed by a facilitator and endeavor to be informed on the subjects to be discussed;

5. a party shall meet with the other party and the facilitator at a mutually acceptable place and time, or, if none can be agreed to, at the time and place designated by the facilitator for a period not to exceed four hours unless the parties agree to a longer period;
6. a party shall endeavor to assure that any facilitation meeting shall be attended by any other persons in their employ that the facilitator requests be present, if reasonably available, including the Architect/Engineer;
7. each party shall participate in such facilitated face-to-face negotiations of the issues in dispute through persons fully authorized to resolve the issue in dispute;
8. each party shall be obligated to participate in negotiations requested by the other party and to perform the specific obligations described in paragraphs (1) through (10) this Article 39, Facilitated Negotiation, no more than three times during the course of the Project;
9. neither party shall be under any obligation to resolve any issue by facilitated negotiation, but each agrees to participate in good faith and the Principal Representative shall direct the Architect/Engineer to appropriately document any resolution or agreement reached and to execute any Amendment or Change Order to the Contract necessary to implement their agreement; and,
10. any discussions and documents prepared exclusively for use in the negotiations shall be deemed to be matters pertaining to settlement negotiations and shall not be subsequently available in further proceedings except to the extent of any documented agreement.

In accordance with State Fiscal Rules and Article 52F, Choice of Law; No Arbitration, nothing in this Article 39 shall be deemed to call for arbitration or otherwise obligate the State to participate in any form of binding alternative dispute resolution.

A partnering plan developed as described in Article 2D, Communications and Cooperation, may modify or expand the requirements of this Article but may not reduce the obligation to participate in facilitated negotiations when applicable. In the case of small projects estimated to be valued under $500,000, the requirements of this Article may be deleted from this Contract, by modification in Article 7 (Contractor's Agreement SC-6.21), Optional Provisions and Elections. When so modified, the references to the parties' right to elect facilitated negotiation elsewhere in these General Conditions shall be deleted.

ARTICLE 40. RIGHT OF OCCUPANCY

The Principal Representative shall have the right to take possession of and to use any completed or partially completed portions of the Work, even if the time for completing the entire Work or portions of the Work has not expired and even if the Work has not been finally accepted, and the Contractor shall fully cooperate with the Principal Representative to allow such possession and use. Such possession and use shall not constitute an acceptance of such portions of the Work.

Prior to any occupancy of the Project, an inspection shall be made by the Principal Representative, State Buildings Program and the Contractor. Such inspection shall be made for the purpose of ensuring that the building is secure, protected by operation safety systems as designed, operable exits, power, lighting and HVAC systems, and otherwise ready for the occupancy intended and the Notice of Substantial Completion has been issued for the occupancy intended. The inspection shall also document existing finish conditions to allow assessment of any damage by occupants. The Contractor shall assist the Principal Representative in completing and executing State Form SBP-01, Approval of Occupancy/Use, prior to the Principal Representative's possession and use. Any and all areas so occupied will be subject to a final inspection when the Contractor complies with Article 41, Completion, Final Inspection, Acceptance and Settlement.

ARTICLE 41. COMPLETION, FINAL INSPECTION, ACCEPTANCE AND SETTLEMENT

A. NOTICE OF COMPLETION

When the Work, or a discrete physical portion of the Work (as hereafter described) which the Principal Representative has agreed to accept separately, is substantially complete and ready for final inspection, the Contractor shall file a written Notice with the Architect/Engineer that the Work, or such discrete physical portion, in the opinion of the Contractor, is substantially complete under the terms of the Contract. The Contractor shall prepare and submit with such Notice a comprehensive list of items to be completed or corrected prior to final payment, which shall be subject to review and additions as the

Architect/Engineer or the Principal Representative shall determine after inspection. If the Architect/Engineer or the Principal Representative believe that any of the items on the list of items submitted, or any other item of Work to be corrected or completed, or the cumulative number of items of Work to be corrected or completed, will prevent a determination that the Work is substantially complete, those items shall be completed by the Contractor and the Notice shall then be resubmitted.

B. FINAL INSPECTION

Within ten (10) days after the Contractor files written Notice that the Work is substantially complete, the Architect/Engineer, the Principal Representative, and the Contractor shall make a "final inspection" of the Project to determine whether the Work is substantially complete and has been completed in accordance with the Contract Documents. State Buildings Program shall be notified of the inspection not less than three (3) business days in advance of the inspection. The Contractor shall provide the Principal Representative and the Architect/Engineer an updated punch list in sufficient detail to fully outline the following:

1. Work to be completed, if any; and
2. Work not in compliance with the Drawings or Specifications, if any.

A final punch list shall be made by the Architect/Engineer in sufficient detail to fully outline to the Contractor:

1. Work to be completed, if any;
2. Work not in compliance with the Drawings or Specifications, if any; and
3. unsatisfactory Work for any reason, if any.

The required number of copies of the final punch list will be countersigned by the authorized representative of the Principal Representative and will then be transmitted by the Architect/Engineer to the Contractor, the Principal Representative, and State Buildings Program. The Architect/Engineer's final punch list shall control over the Contractor's preliminary punch list.

C. NOTICE OF SUBSTANTIAL COMPLETION

Notice of Substantial Completion shall establish the date of substantial completion of the Project. The Contractor acknowledges and agrees that because the departments, agencies and institutions of the State of Colorado are generally involved with the business of the public at large, greater care must be taken in establishing the date of substantial completion than might otherwise be the case to ensure that a project or building or discrete physical portion of the Work is fully usable and safe for public use, and that such care necessarily raises the standard by which the concept of substantial completion is applied for a public building.

The Notice of Substantial Completion shall not be issued until the following have been fully established:

1. All required building code inspections have been called for and the appropriate code officials have affixed their signatures to the Building Inspection Record indicating successful completion of all required code inspections;
2. All required corrections noted on the Building Inspection Record shall have been completed unless the Architect/Engineer, the Principal Representative and State Buildings Program, in their complete and absolute discretion, all concur that the condition requiring the remaining correction is not in any way life threatening, does not otherwise endanger persons or property, and does not result in any undue inconvenience or hardship to the Principal Representative or the public;
3. The building, structure or Project can be fully and comfortably used by the Principal Representative and the public without undue interference by the Contractor's employees and Workers during the completion of the final punch list taking into consideration the nature of the public uses intended and taking into consideration any stage or level of completion of HVAC system commissioning or other system testing required by the Specifications to be completed prior to issuance of the Notice of Substantial Completion;

4. The Project has been fully cleaned as required by these General Conditions, and as required by any stricter requirements of the Specifications, and the overall state of completion is appropriate for presentation to the public; and
5. The Contractor has provided a schedule for the completion of each and every item identified on the punch list which specifies the Subcontractor or trade responsible for the Work, and the dates the completion or correction of the item will be commenced and finished; such schedule will show completion of all remaining final punch list items within the period indicated in the Contract for final punch list completion prior to Final Acceptance, with the exception of only those items which are beyond the control of the Contractor despite due diligence. The schedule shall provide for a reasonable punch list inspection process. Unless liquidated damages have been specified in Article 7.6 of the Contractor's Design/Bid/Build Agreement SC-6.21), the cost to the Principal Representative, if any, for re-inspections due to failure to adhere to the Contractor's proposed punch-list completion schedule shall be the responsibility of the Contractor and may be deducted by the Principal Representative from final amounts due to the Contractor.

Substantial completion of the entire Project shall not be conclusively established by a decision by the Principal Representative to take possession and use of a portion, or all of the Project, where portions of the Project cannot meet all the criteria noted above. Notice of Substantial Completion for the entire Project shall, however, only be withheld for substantial reasons when the Principal Representative has taken possession and uses all of the Project in accordance with the terms of Article 40, Right of Occupancy. Failure to furnish the required completion schedule shall constitute a substantial reason for withholding the issuance of any Notice of Substantial Completion.

The Contractor shall have the right to request a final inspection of any discrete physical portion of the Project when in the opinion of the Principal Representative, The Architect/Engineer and State Buildings Program a final punch list can be reasonably prepared, without confusion as to which portions of the Project are referred to in any subsequent Notice of Partial Final Settlement which might be issued after such portion is finally accepted. Discrete physical portions of the Project may be, but shall not necessarily be limited to, such portions of the Project as separate buildings where a Project consists of multiple buildings. Similarly, an addition to an existing building where the Project also calls for renovation or remodeling of the existing building may constitute a discrete physical portion of the Project. In such circumstances, when in the opinion of the Principal Representative, the Architect/Engineer and State Buildings Program, the requirements for issuance of a Notice of Substantial Completion can be satisfied with respect to the discrete portion of the Project, a partial Notice of Substantial Completion may be issued for such discrete physical portion of the Project.

D. NOTICE OF ACCEPTANCE

The Notice of Acceptance shall establish the completion date of the Project. It shall not be authorized until the Contractor shall have performed all of the Work to allow completion and approval of the Pre-Acceptance Checklist (SBP-05).

Where partial Notices of Substantial Completion have been issued, partial Notices of Final Acceptance may be similarly issued when appropriate for that portion of the Work. Partial Notice of Final Acceptance may also be issued to exclude the Work described in Change Orders executed during late stages of the Project where a later completion date for the Change Ordered Work is expressly provided for in the Contract as amended by the Change Order, provided the Work can be adequately described to allow partial advertisement of any Notice of Partial Final Settlement to be issued without confusion as to the Work included for which final payment will be made.

E. SETTLEMENT

Final payment and settlement shall be made on the date fixed and published for such payment except as hereafter provided. The Principal Representative shall not authorize final payment until all items on the Pre-Acceptance check list (SBP-05) have been completed, the Notice of Acceptance issued, and the Notice of Contractors Settlement published. If the Work shall be substantially completed, but Final Acceptance and completion thereof shall be prevented through delay in correction of minor defects, or unavailability of materials or other causes beyond the control of the Contractor, the Principal

Representative in his or her discretion may release all amounts due to the Contractor except such amounts as may be in excess of three times the cost of completing the unfinished Work or the cost of correcting the defective Work, as estimated by the Architect/Engineer and approved by State Buildings Program. Before the Principal Representative may issue the Notice of Contractor's Settlement and advertise the Project for final payment, the Contractor shall have corrected all items on the punch list except those items for which delayed performance is expressly permitted, subject to withholding for the cost thereof, and shall have:

1. Delivered to the Principal Representative:

    a. All guarantees and warranties;
    b. All statements to support local sales tax refunds, if any;
    c. Required operating maintenance instructions as per the Principal Representative; and,
    d. One (1) set of hard copy as-built Contract Documents, and one (1) electronic copy showing all job changes.

2. Demonstrated to the operating personnel of the Principal Representative the proper operation and maintenance of all equipment.

3. Delivered to the State of Colorado Department of Personnel & Administration in accordance with the Colorado Procurement Code or the applicable procurement code for institutions of higher education:

    a. A written disclosure of the five most costly goods incorporated into the project, including iron, steel, or related manufactured goods and the total cost and country of origin of those five goods and whether the project was subject to any existing domestic content preferences.

Upon completion of the foregoing the Project shall be advertised in accordance with the Notice of Contractor's Settlement by two publications of Notice, the last publication appearing at least ten (10) days prior to the time of final settlement. Publication and final settlement should not be postponed or delayed solely by virtue of unresolved claims against the Project or the Contractor from Subcontractors, suppliers or materialmen based on good faith disputes; the resolution of the question of payment in such cases being directed by statute.

Except as hereafter provided, on the date of final settlement thus advertised, provided the Contractor has submitted a written Notice to the Architect/Engineer that no claims have been filed, and further provided the Principal Representative shall have received no claims, final payments and settlement shall be made in full. If any unpaid claim for labor, materials, rental machinery, tools, supplies or equipment is filed before payment in full of all sums due the Contractor, the Principal Representative and the State Controller shall withhold from the Contractor on the date established for final settlement, sufficient funds to insure the payment of such claim, until the same shall have been paid or withdrawn, such payment or withdrawal to be evidenced by filing a receipt in full or an order for withdrawal signed by the claimant or his or her duly authorized agent or assignee. The amount so withheld may be in the amount of 125% of the claims or such other amount as the Principal Representative reasonably deems necessary to cover expected legal expenses. Such withheld amounts shall be in addition to any amount withheld based on the cost to compete unfinished Work or the cost to repair defective Work. However, as provided by statute, such funds shall not be withheld longer than ninety (90) days following the date fixed for final settlement with the Contractor, as set forth in the published Notice of Contractor's Settlement, unless an action at law shall be commenced within that time to enforce such unpaid claim and a Notice of such action at law shall have been filed with the Principal Representative and the State Controller. At the expiration of the ninety (90) day period, the Principal Representative shall authorize the State Controller to release to the Contractor all other money not the subject of such action at law or withheld based on the cost to compete unfinished Work or the cost to repair defective Work.

Notices of Partial Final Settlement may be similarly advertised, provided all conditions precedent have been satisfied as though that portion of the Work affected stood alone, a Notice of Partial Acceptance

has been issued, and the consent of surety to the partial final settlement has been obtained in writing. Thereafter, partial final payments may be made to the Contractor subject to the same conditions regarding unpaid claims.

ARTICLE 42. GENERAL WARRANTY AND CORRECTION OF WORK AFTER ACCEPTANCE

The Contractor warrants that the materials used and the equipment furnished shall be new and of good quality unless specified to the contrary. The Contractor further warrants that the Work shall, in all respects, be free from material defects not permitted by the Specifications and shall be in accordance with the requirements of the Contract Documents. Neither the final certificate for payment nor any provision in the Contract Documents shall relieve the Contractor of responsibility for defects or faulty materials or Workmanship. The Contractor shall be responsible to the Principal Representative for such warranties for the longest period permitted by any applicable statute of limitations.

In addition to these general warranties, and without limitation of these general warranties, for a period of one year after the date of any Notice of Substantial Completion, or any Notice of Partial Substantial Completion if applicable, the Contractor shall remedy defects, and faulty Workmanship or materials, and Work not in accordance with the Contract Documents which was not accepted at the time of the Notice of Final Acceptance, all in accordance with the provisions of Article 44, One-Year Guarantee And Special Guarantees And Warranties.

ARTICLE 43. LIENS

Colorado statutes do not provide for any right of lien against public buildings. In lieu thereof, C.R.S. § 38-26-107, provides adequate relief for any claimant having furnished labor, materials, rental machinery, tools, equipment, or services toward construction of the particular public Work in that final payment may not be made to a Contractor until all such creditors have been put on Notice by publication in the public press of such pending payment and given opportunity for a period of up to ninety (90) days to stop payment to the Contractor in the amount of such claims.

ARTICLE 44. ONE-YEAR GUARANTEE AND SPECIAL GUARANTEES AND WARRANTIES

A. ONE-YEAR GUARANTEE OF THE WORK

The Contractor shall guarantee to remedy defects and repair or replace the Work for a period of one year from the date of the Notice of Substantial Completion or from the dates of any partial Notices of Substantial Completion issued for discrete physical portions of the Work. The Contractor shall remedy any defects due to faulty materials or Workmanship and shall pay for, repair and replace any damage to other Work resulting there from, which shall appear within a period of one year from the date of such Notice(s) of Substantial Completion. The Contractor shall also remedy any deviation from the requirements of the Contract Documents which shall later be discovered within a period of one year from the date of the Notice of Substantial Completion; provided, however, that the Contractor shall not be required to remedy deviations from the requirements of the Contract Documents where such deviations were obvious, apparent and accepted by the Architect/Engineer or the Principal Representative at the time of the Notice of Final Acceptance. The Principal Representative shall give Notice of observed defects or other Work requiring correction with reasonable promptness. Such Notice shall be in writing to the Architect/Engineer and the Contractor.

The one year guarantee of the Contractor's Work may run separately for discrete physical portions of the Work for which partial Notices of Substantial Completion have been issued, however, it shall run from the last Notice of Substantial Completion with respect to all or any systems common to the Work to which more than one Notice of Substantial Completion may apply.

This one-year guarantee shall not be construed to limit the Contractor's general warranty described in Article 42, General Warranty and Correction of Work After Acceptance, that all materials and equipment are new and of good quality, unless specified to the contrary, and that the Work shall in all respects be free from material defects not permitted by the Specifications and in accordance with the requirements of the Contract Documents.

B. SPECIAL GUARANTEES AND WARRANTIES

In case of Work performed for which product, manufacturers or other special warranties are required by the Specifications, the Contractor shall secure the required warranties and deliver copies thereof to the Principal Representative through the Architect/Engineer upon completion of the Work.

These product, manufacturers or other special warranties, as such, do not in any way lessen the Contractor's responsibilities under the Contract. Whenever guarantees or warranties are required by the Specifications for a longer period than one year, such longer period shall govern.

ARTICLE 45. GUARANTEE INSPECTIONS AFTER COMPLETION

The Architect/Engineer, the Principal Representative and the Contractor together shall make at least two (2) complete inspections of the Work after the Work has been determined to be substantially complete and accepted. One such inspection, the "Six-Month Guarantee Inspection," shall be made approximately six (6) months after date of the Notice of Substantial Completion, unless in the case of smaller projects valued under $500,000 this inspection is declined in Article 7A (Contractor's Agreement SC-6.21), Modification of Article 45, in which case the inspection to occur at six months shall not be required. Another such inspection, the "Eleven-Month Guaranty Inspection" shall be made approximately eleven (11) months after the date of the Notice of Substantial Completion. The Contractor shall schedule and so notify all parties concerned, and the Principal Representative shall so notify State Buildings Program, of these inspections. If more than one Notice of Substantial Completion has been issued at the reasonable discretion of the Principal Representative separate eleven month inspections may be required where the one year guarantees do not run reasonably concurrent.

Written punch lists and reports of these inspections shall be made by the Architect/Engineer and forwarded to the Contractor, the Principal Representative, State Buildings Program, and all other participants within ten (10) days after the completion of the inspections. The punch list shall itemize all guarantee items, prior punch list items still to be corrected or completed and any other requirements of the Contract Documents to be completed which were not waived by final acceptance because they were not obvious or could not reasonably have been previously observed. The Contractor shall immediately initiate such remedial Work as may be necessary to correct any deficiencies or defective Work shown by this report, and shall promptly complete all such remedial Work in a manner satisfactory to the Architect/Engineer, the Principal Representative and State Buildings Program.

If the Contractor fails to promptly correct all deficiencies and defects shown by this report, the Principal Representative may do so, after giving the Contractor ten (10) days written Notice of intention to do so.

The State of Colorado, acting by and through the Principal Representative, shall be entitled to collect from the Contractor all costs and expenses incurred by it in correcting such deficiencies and defects, as well as all damages resulting from such deficiencies and defects.

ARTICLE 46. TIME OF COMPLETION AND LIQUIDATED DAMAGES

It is hereby understood and mutually agreed, by and between the parties hereto, that the date of beginning, rate of progress, and the time for completion of the Work to be done hereunder are ESSENTIAL CONDITIONS of this Agreement, and it is understood and agreed that the Work embraced in this Contract shall be commenced at the time specified in the Notice to Proceed (SC-6.26).

It is further agreed that time is of the essence of each and every portion of this Contract, and of any portion of the Work described on the Drawings or Specifications, wherein a definite and certain length of time is fixed for the performance of any act whatsoever. The parties further agree that where under the Contract additional time is allowed for the completion of the Work or any identified portion of the Work, the new time limit or limits fixed by such extension of the time for completion shall be of the essence of this Agreement.

The Contractor acknowledges that subject to any limitations in the Advertisement for Bids, issued for the Project, the Contractor's bid is consistent with and considers the number of days to substantially complete the Project and the number of days to finally complete the Project to which the parties may have stipulated in the Agreement, which stipulation was based on the Contractor's bid. The Contractor agrees that Work shall be prosecuted regularly, diligently and uninterruptedly at such rate of progress as will ensure the Project will be

substantially complete, and fully and finally complete, as recognized by the issuance of all required Notices of Substantial Completion and Notices of Final Acceptance, within any times stipulated and specified in the Agreement, as the same may be amended by Change Order or other written modification, and that the Principal Representative will be damaged if the times of completion are delayed.

It is expressly understood and agreed, by and between the parties hereto, that the times for the Substantial Completion of the Work or for the final acceptance of the Work as may be stipulated in the Agreement, and as applied here and in Article 7.6 of the Contractor's Design/Bid/Build Agreement SC-6.21), Modifications of Article 46, are reasonable times for these stages of completion of the Work, taking into such consideration all factors, including the average climatic range and usual industrial conditions prevailing in the locality of the building operations.

If the Contractor shall neglect, fail or refuse to complete the Work within the times specified in the Agreement, such failure shall constitute a breach of the terms of the Contract and the State of Colorado, acting by and through the Principal Representative, shall be entitled to liquidated damages for such neglect, failure or refusal, as specified in Article 7.6 of the Contractor's Design/Bid/Build Agreement SC-6.21, Modification of Article 46.

The Contractor and the Contractor's Surety shall be jointly liable for and shall pay the Principal Representative, or the Principal Representative may withhold, the sums hereinafter stipulated as liquidated damages for each calendar day of delay until the entire Project is 1) substantially completed, and the Notice (or all Notices) of Substantial Completion are issued, 2) finally complete and accepted and the Notice (or all Notices) of Acceptance are issued, or 3) both. Delay in substantial completion shall be measured from the Date of the Notice to Proceed and delay in final completion and acceptance shall be measured from the Date of the Notice of Substantial Completion.
In the first instance, specified in Article 7.6.1 of the Contractor's Design/Bid/Build Agreement SC-6.21, Modification of Article 46, liquidated damages, if any, shall be the amount specified therein, for each calendar day of delay beginning after the stipulated number of days for Substantial Completion from the date of the Notice to Proceed, until the date of the Notice of Substantial Completion. Unless otherwise specified in any Supplementary General Conditions, in the event of any partial Notice of Substantial Completion, liquidated damages shall accrue until all required Notices of Substantial Completion are issued.

In the second instance, specified in Article 7.6.2 of the Contractor's Design/Bid/Build Agreement SC-6.21, Modification of Article 46, liquidated damages, if any, shall be the amount specified in Article 7.6.2 of the Contractor's Design/Bid/Build Agreement SC-6.21, Modification of Article 46, for each calendar day in excess of the number of calendar days specified in the Contractor's bid for the Project and stipulated in the Agreement to finally complete the Project (as defined by the issuance of the Notice of Acceptance) after the final Notice of Substantial Completion has been issued.

In the third instance, when so specified in both Articles 7.6.1 and 7.6.2 of the Contractor's Agreement SC-6.21, both types of liquidated damages shall be separately assessed where those delays have occurred.

The parties expressly agree that said amounts are a reasonable estimate of the presumed actual damages that would result from any of the breaches listed, and that any liquidated damages that are assessed have been agreed to in light of the difficulty of ascertaining the actual damages that would be caused by any of these breaches at the time this Contract was formed; the liquidated damages in the first instance representing an estimate of damages due to the inability to use the Project; the liquidated damages in the second instance representing an estimate of damages due to the additional administrative, technical, supervisory and professional expenses related to and arising from the extended closeout period including delivery of any or all guarantees and warranties, the submittals of sales and use tax payment forms, the calling for the final inspection and the completion of the final punch list.

The parties also agree and understand that the liquidated damages to be assessed in each instance are separate and distinct, although potentially cumulative, damages for the separate and distinct breaches of delayed substantial completion or final acceptance. Such liquidated damages shall not be avoided by virtue of the fact of concurrent delay caused by the Principal Representative, or anyone acting on behalf of the

Principal Representative, but in such event the period of delay for which liquidated damages are assessed shall be equitably adjusted in accordance with Article 38, Delays and Extensions Of Time.

ARTICLE 47. DAMAGES

If either party to this Contract shall suffer damage under this Contract in any manner because of any wrongful act or neglect of the other party or of anyone employed by either of them, then the party suffering damage shall be reimbursed by the other party for such damage. Except to the extent of damages liquidated for the Contractor's failure to achieve timely completion as set forth in Article 46, Time of Completion and Liquidated Damages, the Principal Representative shall be responsible for, and at his or her option may insure against, loss of use of any existing property not included in the Work, due to fire or otherwise, however caused. Notwithstanding the foregoing, or any other provision of this Contract, to the contrary, no term or condition of this contract shall be construed or interpreted as a waiver, express or implied, of any of the immunities, rights, benefits, protection, or other provisions of the Colorado Governmental Immunity Act, Section 24-10-101, *et seq.*, CRS, as now or hereafter amended. The parties understand and agree that liability for claims for injuries to persons arising out of negligence of the State of Colorado, its departments, institutions, agencies, boards, officials and employees is controlled and limited by the provisions of Section 24-101-101, *et seq.*, CRS, as now or hereafter amended and the risk management statutes, Section 24-30-1501, *et seq.*, CRS, as now or hereafter amended.

Notice of intent to file a claim under this clause shall be made in writing to the party liable within a reasonable time of the first observance of such damage and not later than the time of final payment, except that in the case of claims by the Principal Representative involving warranties against faulty Work or materials Notice shall be required only to the extent stipulated elsewhere in these General Conditions. Claims made to the Principal Representative involving extra cost or extra time arising by virtue of instructions to the Contractor to which Article 36, Claims, applies shall be made in accordance with Article 36. Other claims arising under the Contract involving extra cost or extra time which are made to the Principal Representative under this clause shall also be made in accordance with the procedures of Article 36, whether or not arising by virtue of instructions to the Contractor; provided however that it shall not be necessary to first obtain or request a written judgment of the Architect/Engineer.

Provided written Notice of intent to file a claim is provided as required in the preceding paragraph, nothing in this Article shall limit or restrict the rights of either party to bring an action at law or to seek other relief to which either party may be entitled, including consequential damages, if any, and shall not be construed to limit the time during which any action might be brought. Nothing in these General Conditions shall be deemed to limit the period of time during which any action may be brought as a matter of contract, tort, warranty or otherwise, it being the intent of the parties to allow any and all actions at law or in equity for such periods as the law permits. All such rights shall, however be subject to the obligation to assert claims and to appeal denials pursuant to Article 36, Claims, where applicable.

ARTICLE 48. STATE'S RIGHT TO DO THE WORK; TEMPORARY SUSPENSION OF WORK; DELAY DAMAGES

A. STATE'S RIGHT TO DO THE WORK

If after receipt of Notice to do so, the Contractor should neglect to prosecute the Work properly or fail to perform any provision of the Contract, the Principal Representative, after a second seven (7) days' advance written Notice to the Contractor and the Surety may, without prejudice to any other remedy the Principal Representative may have, take control of all or a portion of the Work, as the Principal Representative deems necessary and make good such deficiencies deducting the cost thereof from the payment then or thereafter due the Contractor, as provided in Article 30, Correction Of Work Before Acceptance and Article 33, Payments Withheld, provided, however, that the Architect/Engineer shall approve the amount charged to the Contractor by approval of the Change Order.

B. TEMPORARY SUSPENSION OF WORK

The State, acting for itself or by and through the Architect/Engineer, shall have the authority to suspend the Work, either wholly or in part, for such period or periods as may be deemed necessary due to:

1. Unsuitable weather;

2. Faulty Workmanship;
3. Improper superintendence or project management;
4. Contractor's failure to carry out orders or to perform any provision of the Contract Documents;
5: Loss of, or restrictions to, appropriations;
6. Conditions, which may be considered unfavorable for the prosecution of the Work.

If it should become necessary to stop Work for an indefinite period, the Contractor shall store materials in such manner that they will not become an obstruction or become damaged in any way; and he or she shall take every precaution to prevent damage to or deterioration of the Work, provide suitable drainage and erect temporary structures where necessary.

Notice of suspension of Work shall be provided to the Contractor in writing stating the reasons therefore. The Contractor shall again proceed with the Work when so notified in writing.

The Contractor understands and agrees that the State of Colorado cannot predict with certainty future revenues and could ultimately lack the revenue to fund the appropriations applicable to this Contract. The Contractor further acknowledges and agrees that in such event that State may, upon Notice to the Contractor, suspend the Work in anticipation of a termination of the Contract for the convenience of the State, pursuant to Article 50, Termination for Convenience of State. If the Contract is not so terminated the Contract sum and the Contract time shall be equitably adjusted at the time the Principal Representative directs the Work to be recommenced and gives Notice that the revenue to fund the appropriation is available.

C. DELAY DAMAGES

The Principal Representative and the State of Colorado shall be liable to the Contractor for the payment of any claim for extra costs, extra compensation or damages occasioned by hindrances or delays encountered in the Work only when and to the limited extent that such hindrance or delay is caused by an act or omission within the control of the Principal Representative, the Architect/Engineer or other persons or entities acting on behalf of the Principal Representative. Further, the Principal Representative and the State of Colorado shall be liable to the Contractor for the payment of such a claim only if the Contractor has provided required Notice of the delay or impact, or has presented its claim for an extension of time or claim of other delay or other impact due to changes ordered in the Work before proceeding with the changed Work. Except as otherwise provided, claims for extension of time shall be Noticed and filed in accordance with Article 38, Delays and Extensions of Time, within three (3) business days of the beginning of the delay with any claim filed within seven (7) days after the delay has ceased, or such claim is waived. Claims for extension of time or for other delay or other impact resulting from changes ordered in the Work shall be presented and adjusted as provided in Article 35, Changes in the Work.

ARTICLE 49. STATE'S RIGHTS TO TERMINATE CONTRACT

A. GENERAL

If the Contractor should be adjudged bankrupt, or if he or she should make a general assignment for the benefit of his or her creditors, or if a receiver should be appointed to take over his affairs, or if he or she should fail to prosecute his or her Work with due diligence and carry the Work forward in accordance with the construction schedule and the time limits set forth in the Contract Documents, or if he or she should fail to subsequently perform one or more of the provisions of the Contract Documents to be performed by him, the Principal Representative may serve written Notice on the Contractor and the Surety on performance and payment bonds, stating his or her intention to exercise one of the remedies hereinafter set forth and the grounds upon which the Principal Representative bases his or her right to exercise such remedy.

In such event, unless the matter complained of is satisfactorily cleared within ten (10) days after delivery of such Notice, the Principal Representative may, without prejudice to any other right or remedy, exercise one of such remedies at once, having first obtained the concurrence of the Architect/Engineer in writing that sufficient cause exists to justify such action.

B. CONDITIONS AND PROCEDURES

1. The Principal Representative may terminate the services of the Contractor, which termination shall take effect immediately upon service of Notice thereof on the Contractor and his or her Surety, whereupon the Surety shall have the right to take over and perform the Contract. If the Surety does not provide Notice to the Principal Representative of its intent to commence performance of the Contract within ten (10) days after delivery of the Notice of termination, the Principal Representative may take over the Work, take possession of and use all materials, tools, equipment and appliances on the premises and prosecute the Work to completion by such means as he or she shall deem best. In the event of such termination of his or her service, the Contractor shall not be entitled to any further payment under the Contract until the Work is completed and accepted. If the Principal Representative takes over the Work and if the unpaid balance of the contract price exceeds the cost of completing the Work, including compensation for any damages or expenses incurred by the Principal Representative through the default of the Contractor, such excess shall be paid to the Contractor. If, however, the cost, expenses and damages as certified by the Architect/Engineer exceed such unpaid balance of the contract price, the Contractor and his or her Surety shall pay the difference to the Principal Representative.
2. The Principal Representative may require the Surety on the Contractor 's bond to take control of the Work and see to it that all the deficiencies of the Contractor are made good, with due diligence within ten (10) days of delivery of Notice to the Surety to do so. As between the Principal Representative and the Surety, the cost of making good such deficiencies shall all be borne by the Surety. If the Surety takes over the Work, either by election upon termination of the services of the Contractor pursuant to Section B(1) of this Article 49, State's Right To Terminate Contract, or upon instructions from the Principal Representative to do so, the provisions of the Contract Documents shall govern the Work to be done by the Surety, the Surety being substituted for the Contractor as to such provisions, including provisions as to payment for the Work, the times of completion and provisions of this Article as to the right of the Principal Representative to do the Work or to take control of all or a portion of the Work.
3. The Principal Representative may take control of all or a portion of the Work and make good the deficiencies of the Contractor, or the Surety if the Surety has been substituted for the Contractor, with or without terminating the Contract, employing such additional help as the Principal Representative deems advisable in accordance with the provisions of Article 48A, State's Right to Do the Work; Temporary Suspension of Work; Delay Damages. In such event, the Principal Representative shall be entitled to collect from the Contractor and his or her Surety, or to deduct from any payment then or thereafter due the Contractor, the costs incurred in having such deficiencies made good and any damages or expenses incurred through the default of Contractor, provided the Architect/Engineer approves the amount thus charged to the Contractor. If the Contract is not terminated, a Change Order to the Contract shall be executed, unilaterally if necessary, in accordance with the procedures of Article 35, Changes in The Work.

C. ADDITIONAL CONDITIONS

If any termination by the Principal Representative for cause is later determined to have been improper, the termination shall be automatically converted to and deemed to be a termination by the Principal Representative for convenience and the Contractor shall be limited in recovery to the compensation provided for in Article 50, Termination for Convenience of State. Termination by the Contractor shall not be subject to such conversion.

ARTICLE 50. TERMINATION FOR CONVENIENCE OF STATE

A. NOTICE OF TERMINATION

The performance of Work under this Contract may be terminated, in whole or from time to time in part, by the State whenever for any reason the Principal Representative shall determine that such termination is in the best interest of State. Termination of Work hereunder shall be effected by delivery to the Contractor of a Notice of such termination specifying the extent to which the performance of Work under the Contract is terminated and the date upon which such termination becomes effective.

B. PROCEDURES

After receipt of the Notice of termination, the Contractor shall, to the extent appropriate to the termination, cancel outstanding commitments hereunder covering the procurement of materials, supplies, equipment and miscellaneous items. In addition, the Contractor shall exercise all reasonable diligence to accomplish the cancellation or diversion of all applicable outstanding commitments covering personal performance of any Work terminated by the Notice. With respect to such canceled commitments, the Contractor agrees to:

1. settle all outstanding liabilities and all claims arising out of such cancellation of commitments, with approval or ratification of the Principal Representative, to the extent he or she may require, which approval or ratification shall be final for all purposes of this clause; and,
2. assign to the State, in the manner, at the time, and to the extent directed by the Principal Representative, all of the right, title, and interest of the Contractor under the orders and subcontracts so terminated, in which case the State shall have the right, in its discretion, to settle or pay any or all claims arising out of the termination of such orders and subcontracts.

The Contractor shall submit his or her termination claim to the Principal Representative promptly after receipt of a Notice of termination, but in no event later than three (3) months from the effective date thereof, unless one or more extensions in writing are granted by the Principal Representative upon written request of the Contractor within such three-month period or authorized extension thereof. Upon failure of the Contractor to submit his or her termination claim within the time allowed, the Principal Representative may determine, on the basis of information available to him, the amount, if any, due to the Contractor by reason of the termination and shall thereupon pay to the Contractor the amount so determined.

Costs claimed, agreed to, or determined pursuant to the preceding and following paragraph shall be in accordance with the provisions of the Colorado Procurement Code or the applicable procurement code for institutions of higher education.

Subject to the preceding provisions, the Contractor and the Principal Representative may agree upon the whole or any part of the amount or amounts to be paid to the Contractor by reason of the termination under this clause, which amount or amounts may include any reasonable cancellation charges thereby incurred by the Contractor and any reasonable loss upon outstanding commitments for personal services which he or she is unable to cancel; provided, however, that in connection with any outstanding commitments for personal services which the Contractor is unable to cancel, the Contractor shall have exercised reasonable diligence to divert such commitments to other activities and operations. Any such agreement shall be embodied in an Amendment to this Contract and the Contractor shall be paid the agreed amount.

The State may from time to time, under such terms and conditions as it may prescribe, make partial payments against costs incurred by the Contractor in connection with the termination portion of this Contract, whenever, in the opinion of the Principal Representative, the aggregate of such payments is within the amount to which the Contractor will be entitled hereunder.

The Contractor agrees to transfer title and deliver to the State, in the manner, at the time, and to the extent, if any, directed by the Principal Representative, such information and items which, if the Contract had been completed, would have been required to be furnished to the State, including:

a. completed or partially completed plans, Drawings and information; and,
b. materials or equipment produced or in process or acquired in connection with the performance of the Work terminated by the Notice.

Other than the above, any termination inventory resulting from the termination of the Contract may, with written approval of the Principal Representative, be sold or acquired by the Contractor under the conditions prescribed by and at a price or prices approved by the Principal Representative. The proceeds of any such disposition shall be applied in reduction of any payments to be made by the State

to the Contractor under this Contract or shall otherwise be credited to the price or cost of Work covered by this Contract or paid in such other manners as the Principal Representative may direct. Pending final disposition of property arising from the termination, the Contractor agrees to take such action as may be necessary, or as the Principal Representative may direct, for the protection and preservation of the property related to this Contract which is in the possession of the Contractor and in which the State has or may acquire an interest.

Any disputes as to questions of fact, which may arise hereunder, shall be subject to the Remedies provisions of the Colorado Procurement Code or the applicable procurement code for institutions of higher education.

ARTICLE 51. CONTRACTOR'S RIGHT TO STOP WORK AND/OR TERMINATE CONTRACT

If the Work shall be stopped under an order of any court or other public authority for a period of three (3) months through no act or fault of the Contractor or of any one employed by him, then the Contractor may on seven (7) days' written Notice to the Principal Representative and the Architect/Engineer stop Work or terminate this Contract and recover from the Principal Representative payment for all Work executed, any losses sustained on any plant or material, and a reasonable profit only for the Work completed. If the Architect/Engineer shall fail to issue or otherwise act in writing upon any certificate for payment within ten (10) days after it is presented and received by the Architect/Engineer, as provided in Article 31, Applications For Payments, or if the Principal Representative shall fail to pay the Contractor any sum certified that is not disputed in whole or in part by the Principal Representative in writing to the Contractor and the Architect/Engineer within thirty (30) days after the Architect/Engineer's certification, then the Contractor may on ten (10) days' written Notice to the Principal Representative and the Architect/Engineer stop Work and/or give written Notice of intention to terminate this Contract.

If the Principal Representative shall thereafter fail to pay the Contractor any amount certified by the Architect/Engineer and not disputed in writing by the Principal Representative within ten (10) days after receipt of such Notice, then the Contractor may terminate this Contract and recover from the Principal Representative payment for all Work executed, any losses sustained upon any plant or materials, and a reasonable profit only for the Work completed. The Principal Representative's right to dispute an amount certified by the Architect/Engineer shall not relieve the Principal Representative of the obligation to pay amounts not in dispute as certified by the Architect/Engineer.

ARTICLE 52. SPECIAL PROVISIONS

A. CONTROLLER'S APPROVAL C.R.S. § 24-30-202(1)
This contract shall not be valid until it has been approved by the Colorado State Controller or designee.

B. FUND AVAILABILITY C.R.S. § 24-30-202(5.5)
Financial obligations of the State payable after the current fiscal year are contingent upon funds for that purpose being appropriated, budgeted, and otherwise made available.

C. GOVERNMENTAL IMMUNITY
Liability for claims for injuries to persons or property arising from the negligence of the State, its departments, boards, commissions committees, bureaus, offices, employees and officials shall be controlled and limited by the provisions of the Colorado Governmental Immunity Act, C.R.S. § 24-10-101 et seq.; the Federal Tort Claims Act, 28 U.S.C. Pt. VI, Ch. 171 and 28 U.S.C. 1346(b), and the State's risk management statutes, §§24-30-1501, et seq. C.R.S. No term or condition of this contract shall be construed or interpreted as a waiver, express or implied, of any of the immunities, rights, benefits, protections, or other provisions, contained in these statutes.

D. INDEPENDENT CONTRACTOR
Contractor shall perform its duties hereunder as an independent contractor and not as an employee. Neither Contractor nor any agent or employee of Contractor shall be deemed to be an agent or employee of the State. Contractor shall not have authorization, express or implied, to bind the State to any agreement, liability, or understanding, except as expressly set forth herein. **Contractor and its employees and agents are not entitled to unemployment insurance or workers compensation**

benefits through the State and the State shall not pay for or otherwise provide such coverage for Contractor or any of its agents or employees. Contractor shall pay when due all applicable employment taxes and income taxes and local head taxes incurred pursuant to this contract. Contractor shall (a) provide and keep in force workers' compensation and unemployment compensation insurance in the amounts required by law, (b) provide proof thereof when requested by the State, and (c) be solely responsible for its acts and those of its employees and agents.

E. COMPLIANCE WITH LAW

Contractor shall comply with all applicable federal and State laws, rules, and regulations in effect or hereafter established, including, without limitation, laws applicable to discrimination and unfair employment practices.

F. CHOICE OF LAW, JURISDICTION, AND VENUE

Colorado law, and rules and regulations issued pursuant thereto, shall be applied in the interpretation, execution, and enforcement of this Contract. Any provision included or incorporated herein by reference which conflicts with said laws, rules, and regulations shall be null and void. All suits or actions related to this Contract shall be filed and proceedings held in the State of Colorado and exclusive venue shall be in the City and County of Denver.

G. PROHIBITED TERMS

Any term included in this Contract that requires the State to indemnify or hold Contractor harmless; requires the State to agree to binding arbitration; limits Contractor's liability for damages resulting from death, bodily injury, or damage to tangible property; or that conflicts with this provision in any way shall be void ab initio. Nothing in this Contract shall be construed as a waiver of any provision of C.R.S. §24-106-109. Any term included in this Contract that limits Contractor's liability that is not void under this section shall apply only in excess of any insurance to be maintained under this Contract, and no insurance policy shall be interpreted as being subject to any limitations of liability of this Contract.

H. SOFTWARE PIRACY PROHIBITION.

State or other public funds payable under this Contract shall not be used for the acquisition, operation, or maintenance of computer software in violation of federal copyright laws or applicable licensing restrictions. Contractor hereby certifies and warrants that, during the term of this Contract and any extensions, Contractor has and shall maintain in place appropriate systems and controls to prevent such improper use of public funds. If the State determines that Contractor is in violation of this provision, the State may exercise any remedy available at law or in equity or under this Contract, including, without limitation, immediate termination of this contract and any remedy consistent with federal copyright laws or applicable licensing restrictions.

I. EMPLOYEE FINANCIAL INTEREST/CONFLICT OF INTEREST C.R.S. § 24-18-201 & C.R.S. § 24-50-507

The signatories aver that to their knowledge, no employee of the State has any personal or beneficial interest whatsoever in the service or property described in this contract. Contractor has no interest and shall not acquire any interest, direct or indirect, that would conflict in any manner or degree with the performance of Contractor's services and Contractor shall not employ any person having such known interests.

J. VENDOR OFFSET AND ERRONEOUS PAYMENTS C.R.S. § 24-30-202(1) & C.R.S. § 24-30-202.4

The State Controller may withhold payment under the State's vendor offset intercept system for debts owed to State Agencies for: **(a)** unpaid child support debts or child support arrearages; **(b)** unpaid balances of tax, accrued interest, or other charges specified in §39-21-101, et seq. C.R.S.; **(c)** unpaid loans due to the Student Loan Division of the Department of Higher Education; **(d)** amounts required to be paid to the Unemployment Compensation Fund; and **(e)** other unpaid debts owing to the State as a result of final agency determination or judicial action. The State may also recover, at the State's discretion, payments made to Contractor in error for any reason, including, but not limited to, overpayments or improper payments, and unexpended or excess funds received by Contractor by

deduction from subsequent payments under this Contract, deduction from any payment due under any other contracts, grants or agreements between the State and Contractor, or by any other appropriate method for collecting debts owed to the State.

K. PUBLIC CONTRACTS FOR SERVICES. C.R.S. § 8-17.5-101.
Contractor certifies, warrants, and agrees that it does not knowingly employ or contract with an illegal alien who will perform work under this Contract and will confirm the employment eligibility of all employees who are newly hired for employment in the United States to perform work under this contract, through participation in the E-Verify Program or the Department program established pursuant to C.R.S. § 8-17.5-102(5)(c), Contractor shall not knowingly employ or contract with an illegal alien to perform work under this Contract or enter into a contract with a subcontractor that fails to certify to Contractor that the subcontractor shall not knowingly employ or contract with an illegal alien to perform work under this Contract. Contractor **(a)** shall not use E-Verify Program or Department program procedures to undertake pre-employment screening of job applicants while this Contract is being performed, **(b)** shall notify the subcontractor and the contracting State Agency within three days if Contractor has actual knowledge that a subcontractor is employing or contracting with an illegal alien for work under this Contract, **(c)** shall terminate the subcontract if a subcontractor does not stop employing or contracting with the illegal alien within three days of receiving the notice, and **(d)** shall comply with reasonable requests made in the course of an investigation, undertaken pursuant to C.R.S. § 8-17.5-102(5), by the Colorado Department of Labor and Employment. If Contractor participates in the Department program, Contractor shall deliver to the contracting State Agency, Institution of Higher Education or political subdivision a written, notarized affirmation, affirming that Contractor has examined the legal work status of such employee, and shall comply with all of the other requirements of the Department program. If Contractor fails to comply with any requirement of this provision or C.R.S.§ 8-17.5-101 et seq., the contracting State Agency, Institution of Higher Education or political subdivision may terminate this Contract for breach and, if so terminated, Contractor shall be liable for damages.

L. PUBLIC CONTRACTS WITH NATURAL PERSONS. C.R.S. § 24-76.5-101.
Contractor, if a natural person eighteen (18) years of age or older, hereby swears and affirms under penalty of perjury that Contractor **(a)** is a citizen or otherwise lawfully present in the United States pursuant to federal law, **(b)** shall comply with the provisions of C.R.S. § 24-76.5-101 et seq., and **(c)** has produced one form of identification required by C.R.S. § 24-76.5-103 prior to the effective date of this Contract.

ARTICLE 53. MISCELLANEOUS PROVISIONS

A. CONSTRUCTION OF LANGUAGE
The language used in these General Conditions shall be construed as a whole according to its plain meaning, and not strictly for or against any party. Such construction shall, however, construe language to interpret the intent of the parties giving due consideration to the order of precedence noted in Article 2C, Intent of Documents.

B. SEVERABILITY
Provided this Agreement can be executed and performance of the obligations of the Parties accomplished within its intent, the provisions hereof are severable and any provision that is declared invalid or becomes inoperable for any reason shall not affect the validity of any other provision hereof, provided that the Parties can continue to perform their obligations under this Agreement in accordance with its intent.

C. SECTION HEADINGS
The captions and headings in this Agreement are for convenience of reference only, and shall not be used to interpret, define, or limit its provisions.

D. AUTHORITY
Each person executing the Agreement and its Exhibits in a representative capacity expressly represents and warrants that he or she has been duly authorized by one of the parties to execute the Agreement and has authority to bind said party to the terms and conditions hereof.

E. INTEGRATION OF UNDERSTANDING

This Contract is intended as the complete integration of all understandings between the parties and supersedes all prior negotiations, representations, or agreements, whether written or oral. No prior or contemporaneous addition, deletion, or other amendment hereto shall have any force or affect whatsoever, unless embodied herein in writing. No subsequent novation, renewal, addition, deletion, or other amendment hereto shall have any force or effect unless embodied in a written Change Order or Amendment to this Contract.

F. NO THIRD PARTY BENEFICIARIES

Enforcement of this Agreement and all rights and obligations hereunder are reserved solely to the Parties. Any services or benefits which third parties receive as a result of this Contract are incidental to the Contract, and do not create any rights for such third parties.

G. WAIVER

Waiver of any breach under a term, provision, or requirement of this Agreement, or any right or remedy hereunder, whether explicitly or by lack of enforcement, shall not be construed or deemed as a waiver of any subsequent breach of such term, provision or requirement, or of any other term, provision, or requirement.

H. INDEMNIFICATION

Contractor shall indemnify, save, and hold harmless the State, its employees and agents, against any and all claims, damages, liability and court awards including costs, expenses, and attorney fees , to the extent such claims are caused by any negligent act or omission of the Contractor, its employees, agents, subcontractors or assignees pursuant to the terms of this Contract, but not to the extent such claims are caused by any negligent act or omission of, or breach of contract by, the State, its employees, agents, other contractors or assignees, or other parties not under control of or responsible to the Contractor.

I. STATEWIDE CONTRACT MANAGEMENT SYSTEM

If the maximum amount payable to Contractor under this Contract is $100,000 or greater, either on the Effective Date or at any time thereafter, this shall apply. Contractor agrees to be governed by and comply with the Colorado Procurement Code or the applicable procurement code for institutions of higher education, regarding the monitoring of vendor performance and the reporting of contract performance information in the State's contract management system ("Contract Management System" or "CMS"). Contractor performance shall be subject to evaluation and review in accordance with the terms and conditions of this Contract, Colorado statutes governing CMS, and State Fiscal Rules and State Controller policies.

J. CORA DISCLOSURE

To the extent not prohibited by federal law, this Agreement and the performance measures and standards under the Colorado Procurement Code or the applicable procurement code for institutions of higher education, if any, are subject to public release through the Colorado Open Records Act, C.R.S. § 24-72-201, et seq.

SECTION 00 73 00 – CONSTRUCTION PURCHASE ORDER TERMS AND CONDITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

1.3 DEFINITIONS (Not Applicable)

1.4 CONSTRUCTION PURCHASE ORDER TERMS AND CONDITIONS

A. A. The University of Colorado Denver | Anschutz Medical Campus Construction Purchase Order Terms and Conditions apply to Contractors Agreement (D/B/B) (SC-6.21) and General Conditions to the Contract (SC-6.23).

B. A copy of the above noted document is attached to the end of this section.

1.5 PROCEDURE (Not applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 73 00

University of Colorado
Denver | Anschutz Medical Campus

Facilities Management
Construction Purchase Order Terms and Conditions

1. Offer/Acceptance

If this purchase order ("PO") refers to vendor's bid or proposal, this PO is an ACCEPTANCE of vendor's OFFER TO SELL in accordance with the terms and conditions of the "solicitation" identified in vendor's bid or proposal. The solicitation includes an RFP, IFB, or any other form of order by the University. If a bid or proposal is not referenced, this PO is an OFFER TO BUY, subject to vendor's acceptance, demonstrated by vendor's performance or written acceptance of this PO. Any COUNTER-OFFER TO SELL automatically CANCELS this PO, unless a change order is issued by the University accepting a counter-offer. This PO shall supersede and control over any vendor form(s) or part(s) thereof included in or attached to any bid, proposal, offer, acknowledgment, or otherwise, in the event of inconsistencies or contradictions, regardless of any statement to the contrary in such form(s) or parts thereof.

2. Safety Information

All chemicals, equipment and materials proposed and/or used in the performance of this PO shall conform to the requirements of the Occupational Safety and Health Act of 1970. Vendor shall furnish all Material Safety Data Sheets (MSDS) for any regulated chemicals, equipment or hazardous materials at the time of delivery.

3. Changes

Vendor shall furnish products and/or services strictly in accordance with the specifications and price set forth for each item. This PO shall not be modified, superseded or otherwise altered, except in writing signed by purchasing agent and accepted by vendor. Each shipment received or service performed shall comply with the terms of this PO, notwithstanding invoice terms or acts of vendor to the contrary, unless this PO has been modified, superseded or otherwise altered in accordance with this section.

4. Delivery

Unless otherwise specified in the solicitation or this PO, delivery shall be FOB destination. The University is relying on the promised delivery date, installation, and/or service performance set forth in vendor's bid or proposal as material and basic to the University’s acceptance. If vendor fails to deliver or perform as and when promised, the University in its sole discretion, may cancel its order, or any part thereof, without prejudice to its other rights, return all or part of any shipment so made, and charge vendor with any loss or expense sustained as a result of such failure to deliver or perform as promised. Time is of the essence.

5. Intellectual Property

Any software, research, reports, studies, data, photographs, negatives or other documents, drawings or materials (collectively "materials") delivered by vendor in performance of its obligations under this PO shall be the exclusive property of the University. Ownership rights shall include, but not be limited to, the right to copy, publish, display, transfer, prepare derivative works, or otherwise use the materials. Vendor shall comply with all applicable laws, regulations and University policies related to confidential information and all confidentiality and non-disclosure agreements, security controls, and reporting requirements.

6. Quality

The University shall be the sole judge in determining "equals" with regard to quality, price and performance. All products delivered shall be newly manufactured and the current model, unless otherwise specified.

7. Warranties

All provisions and remedies of the Colorado Uniform Commercial Code, CRS, Title 4 ("CUCC"), relating to implied and/or express warranties are incorporated herein, in addition to any warranties contained in this PO or the specifications.

8. Inspections and Acceptance

Final acceptance is contingent upon completion of all applicable inspection procedures. If products or services fail to meet any inspection requirements, the University may exercise all of its rights, including those provided in the CUCC. The University shall have the right to inspect services provided under this PO at all reasonable times and places. "Services" as used in this section includes services performed or tangible material produced or delivered in the performance of services. If any of the services do not conform to PO requirements, the University may require vendor to perform the services again in conformity with PO requirements, without additional payment. When defects in the quality or quantity of service cannot be corrected by re-performance, the University may (a) require vendor to take necessary action to ensure that future performance conforms to PO requirements and (b) equitably reduce the payment due vendor to reflect the reduced value of the services performed. These remedies do not limit the remedies otherwise available in this PO, at law, or in equity.

9. Cash Discount

The cash discount period will start from the later of the date of receipt of acceptable invoice, or from date of receipt of acceptable products/services at the specified destination by an authorized University representative.

10. Taxes

The University is exempt from all federal excise taxes under Chapter 32 of the Internal Revenue Code and from all State and local government sales and use taxes [CRS, Title 39, Article 26, Parts I and II].

11. Payment

The University shall pay vendor for all amounts due within 30 days after receipt of products or services and a correct notice of amount due. Interest on the unpaid balance shall begin to accrue on the 46th day at the applicable statutory rate. Interest shall not accrue if a good faith dispute exists as to the University's obligation to pay all or a portion of the amount due. Vendor shall invoice the University separately for interest on delinquent amounts due, referencing the delinquent payment, number of day's interest to be paid, and applicable interest rate.

12. Vendor Offset

[Not Applicable to Inter-governmental POs] The University may withhold payment as required under the State vendor offset intercept system for debts owed for: (a) unpaid child support debts or arrearages; (b) unpaid balances of tax, accrued interest, or other charges specified in CRS § 39-21-101, et seq.; (c) unpaid loans due to the Student Loan Division of the Department of Higher Education; (d) amounts required to be paid to the Unemployment Compensation Fund; and (e) other unpaid debts owing to the University.

13. Assignment and Successors

Vendor shall not assign rights or delegate duties under this PO, or subcontract any part of the performance required under this PO, without the express, written consent of the University. This PO shall inure to the benefit of and be binding upon vendor and the University and their respective successors and assigns. Assignment of accounts receivable may be made only upon written notice furnished to the University.

14. Indemnification

If any article sold or delivered under this PO is covered by a patent, copyright, trademark, or application therefore, vendor shall indemnify and hold harmless the University from any and all loss, liability, cost, expenses and legal fees incurred on account of any claims, legal actions or judgments arising out of manufacture, sale or use of such article in violation or infringement of rights under such patent, copyright, trademark or application. If this PO is for services, vendor shall indemnify, save, and hold harmless the University, its employees and agents, against any and all claims, damages, liability and court awards including costs, expenses, and attorney fees and related expenses, incurred as a result of any act or omission by vendor, or its employees, agents, subcontractors or assignees, arising out of or in connection with performance of services under this PO.

15. Independent Contractor

Vendor shall perform its duties hereunder as an independent contractor and not as an employee. Neither vendor nor any agent or employee of vendor shall be deemed to be an agent or employee of the University. Vendor and its employees and agents are not entitled to unemployment insurance or workers compensation benefits through the University and the University shall not pay for or otherwise provide such coverage for vendor or any of its agents or employees. Unemployment insurance benefits will be available to vendor and its employees and agents only if coverage is made available by vendor or a third party. Vendor shall pay when due all applicable employment, income, and local head taxes incurred pursuant to this PO. Vendor shall not have authorization, express or implied, to bind the University to any agreement, liability or understanding. Vendor shall (a) provide and keep in force workers' compensation and unemployment compensation insurance in the amounts required by law, (b) provide proof thereof when requested by the University, and (c) be solely responsible for its acts and those of its employees and agents.

16. Communication

All communication concerning administration of this PO, prepared by vendor for the University’s use, shall be furnished solely to purchasing agent.

17. Compliance

Vendor shall strictly comply with all applicable federal and state laws, rules, and regulations in effect or hereafter established, including, without limitation, laws applicable to discrimination and unfair employment practices.

18. Insurance

Vendor shall obtain, and maintain, at all times during the term of this PO, insurance as specified in the solicitation, and provide proof of such coverage as requested by the University's purchasing agent.

19. Termination Prior to Shipment

If vendor has not accepted this PO in writing, the University may cancel this PO by written or oral notice to vendor prior to shipment of goods or commencement of services.

20. Termination for Cause

(a) If vendor refuses or fails to timely and properly perform any of its obligations under this PO with such diligence as will ensure its completion within the time specified herein, the University may notify vendor in writing of non-performance and, if not corrected by vendor within the time specified in the notice, terminate vendor's right to proceed with the PO or such part thereof as to which there has been delay or a failure. Vendor shall continue performance of this PO to the extent not terminated and be liable for excess costs incurred by the University in procuring similar goods or services elsewhere. Payment for completed services performed and accepted shall be at the price set forth in this PO. (b) The University may withhold amounts due to vendor as the University deems necessary to reimburse the University for excess costs incurred in curing, completing or procuring similar goods and services.(c) If after rejection, revocation, or other termination of vendor's right to proceed under the CUCC or this clause, the University determines for any reason that vendor was not in default or the delay was excusable, the rights and obligations of the University and vendor shall be the same as if the notice of termination had been issued pursuant to termination under § 21.

21. Termination in Public Interest

The University is entering into this PO for the purpose of carrying out the public policy of the State and University, as determined by the Governor, General Assembly and Courts of the State of Colorado and the University of Colorado Board of Regents. If this PO ceases to further the public policy of the State or University, the University, in its sole discretion, may terminate this PO in whole or in part and such termination shall not be deemed to be a breach of the University's obligations hereunder. This section shall not apply to a termination for vendor's breach, which shall be governed by Item 20 (Termination for Cause). The University shall give written notice of termination to vendor specifying the part of the PO terminated and when termination becomes effective. Upon receipt of notice of termination, vendor shall not incur further obligations except as necessary to mitigate costs of performance. For services or specially manufactured goods, the University shall pay (a) reasonable settlement expenses, (b) the PO price or rate for supplies and services delivered and accepted, (c) reasonable costs of performance on unaccepted supplies and services, and (d) a reasonable profit for the unaccepted work. For existing goods, the University shall pay (e) reasonable settlement expenses, (f) the PO price for goods delivered and accepted, (g) reasonable costs incurred in preparation for delivery of the undelivered goods, and (h) a reasonable profit for the preparatory work. The University's termination liability under this section shall not exceed the total PO price plus a reasonable cost for settlement expenses. Vendor shall submit a termination proposal and reasonable supporting documentation, and cost and pricing data as required by CRS § 24-106-101, upon request of the University.

22. PO Approval

This PO shall not be valid unless it is executed by purchasing agent. The University shall not be responsible or liable for products or services delivered or performed prior to proper execution hereof.

23. Fund Availability

Financial obligations of the University payable after the current fiscal year are contingent upon funds for that purpose being budgeted and otherwise made available. If this PO is funded in whole or in part with federal funds, this PO is subject to and contingent upon the continuing availability of federal funds for the purposes hereof. The University represents that it has set aside sufficient funds to make payment for goods delivered in a single installment, in accordance with the terms of this PO.

24. Choice of Law

Colorado laws, rules and regulations shall be applied in the interpretation, execution, and enforcement of this PO. The CUCC shall govern this PO in the case of goods unless otherwise agreed in this PO. Any provision included or incorporated herein by reference which conflicts with such laws, rules, and regulations is null and void. Any provision incorporated herein by reference which purports to negate this or any other provision in this PO in whole or in part shall not be valid or enforceable or available in any action at law, whether by way of complaint, defense, or otherwise. Unless otherwise specified in the solicitation or this PO, venue for any judicial or administrative action arising out of or in connection with this PO shall be in Denver, Colorado. Vendor shall exhaust administrative remedies in CRS § 24-109-106, prior to commencing any judicial action against the University.

25. Sensitive Data

To the extent vendors comes in contact with individual personal data owned or otherwise held by the University **including employee, student, or medical information or records** as a result of performing under this PO ("Data"), vendor agrees to use such Data, if at all, only to the extent required to perform its obligations under this PO, and to abide by the requirements of any federal, state and local laws that address the protection and/or use of such Data.

26. Background Checks

Contractor acknowledges that Contractor's activities may involve heightened risks as a result of access or exposure by Contractor's employees or agents to one or more Sensitive Environments. Contractor expressly acknowledges that Contractor shall take all commercially reasonable measures to mitigate any such risks, which measures may include but are not limited to conducting criminal history checks, financial background checks, or reference checks on employees or agents who will have access to one or more Sensitive Environments. For purposes of this provision, Sensitive Environment means any situation where Contractor's employees or agents: (a) are engaged in supervision of or exposure to minors or other vulnerable populations; (b) have access to confidential information, which includes any information protected or restricted by law or University policy or that is expressly identified by the University as confidential information; (c) have access to the University's information technology systems; (d) are engaged in activities that involve unique or specialized risks.

27. Public Contracts for Service

[Not Applicable to offer, issuance, or sale of securities, investment advisory services, fund management services, sponsored projects, intergovernmental POs, or information technology services or products and services] Vendor certifies, warrants, and agrees that it does not knowingly employ or contract with an illegal alien who will perform work under this PO and will confirm the employment eligibility of all employees who are newly hired for employment in the United States to perform work under this PO, through participation in the E-Verify Program or the Department program established pursuant to CRS § 8-17.5-102(5)(c), Vendor shall not knowingly employ or contract with an illegal alien to perform work under this PO or enter into a contract or PO with a subcontractor that fails to certify to vendor that the subcontractor shall not knowingly employ or contract with an illegal alien to perform work under this PO. Vendor shall (a) not use E-Verify Program or Department program procedures to undertake pre-employment screening of job applicants during performance of this PO, (b) notify subcontractor and the University within three days if vendor has actual knowledge that subcontractor is employing or contracting with an illegal alien for work under this PO, (c) terminate the subcontract if subcontractor does not stop employing or contracting with the illegal alien within three days of receiving notice, and (d) comply with reasonable requests made in the course of an investigation, undertaken pursuant to CRS § 8-17.5-102(5), by the Colorado Department of Labor and Employment. If vendor participates in the Department program, vendor shall deliver to the University a written, notarized affirmation that vendor has examined the legal work status of such employee, and shall comply with all of the other requirements of the Department program. If vendor fails to comply with any requirement of this provision or CRS § 8-17.5-101

et seq., the University may terminate this PO for breach and, if so terminated, vendor shall be liable for damages.

28. Public Contracts with Natural Persons

Vendor, if a natural person eighteen (18) years of age or older, hereby swears and affirms under penalty of perjury that he or she (a) is a citizen or otherwise lawfully present in the United States pursuant to federal law, (b) shall comply with the provisions of CRS § 24-76.5-101 et seq., and (c) has produced a form of identification required by CRS § 24-76.5-103 prior to the date vendor delivers goods or begins performing services under terms of the PO.

29. Governmental Immunity.

No term or condition of this contract shall be construed or interpreted as a waiver, express or implied, of any of the immunities, rights, benefits, protections, or other provisions, of the Colorado Governmental Immunity Act, CRS §24-10-101 et seq., or the Federal Tort Claims Act, 28 U.S.C. §§1346(b) and 2671 et seq., as applicable now or hereafter amended.

30. Employee Financial Interest/Conflict Of Interest. CRS §§24-18-201 and 24-50-507.

The signatories aver that to their knowledge, no employee of the University has any personal or beneficial interest whatsoever in the service or property described in this contract. Contractor has no interest and shall not acquire any interest, direct or indirect, that would conflict in any manner or degree with the performance of Contractor's services and Contractor shall not employ any person having such known interests

31. Federal Flowdown Provisions for Federally Funded Contracts

The University of Colorado has entered into an Agreement with either the U.S. Government, or another entity who has itself entered into an Agreement with the U.S. Government. That Agreement requires that certain federal contract provisions be made a part of any subsequent Purchase Order issued by the University of Colorado related to furthering the performance or deliverables required under that Agreement.
Where necessary to make the context of these provisions applicable to this order, the term "contractor" shall mean "seller," the term "contract" shall mean "this order," and the terms "Government," "contracting officer," and equivalent phrases shall mean "the University." Seller hereby agrees to flowdown the applicable clauses to its lower-tier subcontractors, and agrees that the clauses are in effect between it and the University, as applicable.

The following provisions are from the Federal Acquisition Regulations (FAR), which are available online. (NOTE: These FAR clauses may have applicability only when the Purchase Order is at or in excess of a certain dollar threshold, shown in parentheses, or under certain circumstances.)

FAR Citation	Title
52.203-6	Restrictions on Subcontractor Sales to the Government ($100,000)
52.203-7	Anti-Kickback Procedures except Subparagraph (c)(1) ($100,000)
52.203-12	Limitation on Payments to Influence Certain Federal Transactions ($100,000)
52.204-2	Security Requirements (applicable if access to classified material is involved) ($0)
52.215-2	Audit and Records -- Negotiation ($100,000)

FAR Citation	Title
52.215-10	Price Reduction for Defective Cost or Pricing Data ($550,000)
52.215-12	Subcontractor Cost or Pricing Data ($550,000)
52.215-13	Subcontractor Cost or Pricing Data -- Modifications ($550,000)
52.215-14	Integrity of Unit Prices ($100,000)
52.219-8	Utilization of Small Business Concerns ($100,000)
52.219-9	Small Business and Small Disadvantaged Business Subcontracting Plans (Large Businesses) ($650,000)
52.219-16	Liquidated Damages -- Subcontracting Plan ($650,000)
52.222-4	Contract Work Hours and Safety Standards Act -- Overtime Compensation ($100,000)
52.222-21	Prohibition of Segregated Facilities ($10,000)
52.222-26	Equal Opportunity ($10,000)
52.222-35	Affirmative Action for Disabled Veterans and Veterans of the Vietnam Era ($25,000)
52.222-36	Affirmative Action for Workers with Disabilities ($10,000)
52.222-37	Employment Reports on Disabled Veterans and Veterans of the Vietnam Era ($25,000)
52.223-2	Clean Air and Water (applicable on orders issued under contracts solicited and issued prior to February 25, 2000)
52.223-6	Drug-Free Workplace (for individuals, $0; for non-individuals, $100,000)
52.223-7	Notice of Radioactive Materials (applicable if radioactive materials are involved) ($0)
52.223-14	Toxic Chemical Release Reporting ($100,000; N/A for acquisition of commercial items)
52.224-2	Privacy Act (applicable if vendor is supplying design, development, or operation of a system of records on individuals) ($0)
52.225-3	Buy American Act - Free Trade Agreements - Israeli Trade Act ($0)
52.225-13	Restrictions on Certain Foreign Purchases ($2,500)
52.226-1	Utilization of Indian Organizations and Indian-Owned Economic Enterprises ($0)
52.227-1	Authorization and Consent (applicable if in excess of the simplified acquisition threshold)
52.227-2	Notice and Assistance Regarding Patent and Copyright Infringement (applicable if in excess of the simplified acquisition threshold)
52.227-10	Filing of Patent Applications -- Classified Subject Matter ($0)
52.227-11	Patent Rights -- Retention by the Contractor (Short Form) ($0)
52.227-14	Rights in Data - General ($0)
52.230-5	Cost Accounting Standards -- Educational Institutions ($500,000)

FAR Citation	Title
52.230-6	Administration of Cost Accounting Standards ($500,000)
52.244-6	Subcontract for Commercial Items and Commercial Components ($0; non-commercial supplies or services)
52.245-5	Government Property (Cost Reimbursement, Time-and-Materials, or Labor-Hour Contracts) (paragraph "g" Limited risk of loss is not applicable) ($0)
52.247-63	Preference for U.S.-Flag Air Carriers ($100,000)
52.247-64	Preference for Privately Owned U.S.-Flag Commercial Vessels ($0)

In addition, if federal funds through a contract from an agency of the Department of Defense are involved, the following Department of Defense Federal Acquisition Regulations (DFAR) clauses apply. DFAR clauses are available online.
(NOTE: These DFAR clauses may have applicability only when the Purchase Order is at or in excess of a certain dollar threshold, shown in parentheses, or under certain circumstances.)

DFAR Citation	Title
252.203-7001	Prohibition on Persons Convicted of fraud or Other Defense-Contract Related Felonies (not applicable for commercial items) (applicable if at or in excess of the simplified acquisition threshold)
252.209-7000	Acquisition from Subcontractors Subject to On-Site Inspection Under the Intermediate Range Nuclear Forces (INF) Treaty (applicable if at or in excess of The simplified acquisition threshold) (not applicable for commercial items)
252.227-7013	Rights in Technical Data -- Noncommercial Items ($0)
252.227-7014	Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation
252.227-7034	Patents - Subcontracts ($0, for experimental, developmental, or research work to be performed by other than a small business firm or non-profit organization)
252.231-7000	Supplemental Cost Principles ($0)

In addition, if federal funds through a contract from the National Aeronautic and Space Administration (NASA) are involved, the following NASA Supplemental Federal Acquisition Regulations (FAR) clauses apply. NASA clauses are available online.
(NOTE: These NASA clauses may have applicability only when the Purchase Order is at or in excess of a certain dollar threshold, shown in parentheses, or under certain circumstances.)

NASA Citation	Title
1852.208-81	Restrictions on Printing and Duplicating, Oct 2001 ($0)
1852.219-74	Use of Rural Area Small Businesses, Sept 1990 ($0)
1852.219-75	Small Business Subcontracting Reporting, May 1999 ($500,000)
1852.223-70	Safety and Health, April 2002 ((1) Amount to $1,000,000 or more (unless Contracting Officer makes a written determination, after consultation with installation safety and health representatives, that this is not required); (2)

NASA Citation	Title
	Require construction, repair, or alteration in excess of $25,000; or (3) Regardless of dollar amount, involve the use of hazardous materials or operations.)
1852.227-70	New Technology, May 2002 ($0, for the performance of experimental, developmental, or research work)
1852.227-71	Designation of New Technology Representative and Patent Representative, July 1997 ($0)
1852.244-70	Geographic Participation in the Aerospace Program, Apr 1985 ($100,000)

30. Federal Flowdown Provisions for Federally Funded Grants

The University of Colorado has entered into an Agreement with either the U.S. Government, or another entity who has itself entered into an Agreement with the U.S. Government. That Agreement requires that certain federal grant provisions be made a part of any subsequent Purchase Order issued by the University of Colorado related to furthering the performance or deliverables required under that Agreement.
Where necessary to make the context of these provisions applicable to this order, the term "contractor" shall mean "seller," the term "contract" shall mean "this order," and the terms "Government," "contracting officer," and equivalent phrases shall mean "the University." Seller hereby agrees to flowdown the applicable clauses to its lower-tier subcontractors, and agrees that the clauses are in effect between it and the University, as applicable.

Performance by the seller under this Purchase Order constitutes certification that the seller is presently in compliance with, and will continue to comply with, the Byrd Anti-Lobbying Amendment (31 U.S.C. 1352) and Executive Orders Numbers 12549 and 12689, all as described below.

Equal Employment Opportunity

All contracts shall contain a provision requiring compliance with E.O. 11246, "Equal Employment Opportunity," as amended by E.O. 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and as supplemented by regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."

Copeland "Anti-Kickback" Act (18 U.S.C. 874 and 40 U.S.C. 276c)

All contracts and subgrants in excess of $2000 for construction or repair awarded by recipients and subrecipients shall include a provision for compliance with the Copeland "Anti-Kickback" Act (18 U.S.C. 874), as supplemented by Department of Labor regulations (29 CFR part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each contractor or subrecipient shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he is otherwise entitled. The recipient shall report all suspected or reported violations to the Federal awarding agency.

Davis-Bacon Act, as amended (40 U.S.C. 276a to a-7)

When required by Federal program legislation, all construction contracts awarded by the recipients and subrecipients of more than $2000 shall include a provision for compliance with the Davis-Bacon Act (40 U.S.C. 276a to a-7) and as supplemented by Department of Labor regulations (29 CFR part 5, "Labor Standards Provisions Applicable to Contracts Governing Federally Financed and Assisted Construction").

Under this Act, contractors shall be required to pay wages to laborers and mechanics at a rate not less than the minimum wages specified in a wage determination made by the Secretary of Labor. In addition, contractors shall be required to pay wages not less than once a week. The recipient shall place a copy of the current prevailing wage determination issued by the Department of Labor in each solicitation and the award of a contract shall be conditioned upon the acceptance of the wage determination. The recipient shall report all suspected or reported violations to the Federal awarding agency.

Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333)

Where applicable, all contracts awarded by recipients in excess of $2000 for construction contracts and in excess of $2500 for other contracts that involve the employment of mechanics or laborers shall include a provision for compliance with Sections 102 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333), as supplemented by Department of Labor regulations (29 CFR part 5). Under Section 102 of the Act, each contractor shall be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than 1 1/2 times the basic rate of pay for all hours worked in excess of 40 hours in the work week. Section 107 of the Act is applicable to construction work and provides that no laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

Rights to Inventions Made Under a Contract or Agreement

Contracts or agreements for the performance of experimental, developmental, or research work shall provide for the rights of the Federal Government and the recipient in any resulting invention in accordance with 37 CFR part 401, "Rights to Inventions made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by the awarding agency.

Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.), as amended

Contracts and subgrants of amounts in excess of $100,000 shall contain a provision that requires the recipient to agree to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251 et seq.). Violations shall be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).

Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)

Contractors who apply or bid for an award of $100,000 or more shall file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient.

Debarment and Suspension (E.O.s 12549 and 12689)

No contract shall be made to parties listed on the General Services Administration's List of Parties Excluded from Federal Procurement or Nonprocurement Programs in accordance with E.O.s 12549 and

12689, "Debarment and Suspension." This list contains the names of parties debarred, suspended, or otherwise excluded by agencies, and contracts declared ineligible under statutory or regulatory authority other than E.O. 12549. Contractors with awards that exceed the small purchase threshold shall provide the required certification regarding its exclusion status and that of its principal employees.

Access to Records (OMB Circular A-110, .48(d))

All negotiated contracts (except those for less than the small purchase threshold) awarded by recipients shall include a provision to the effect that the recipient, the Federal awarding agency, the Comptroller General of the United States, or any of their duly authorized representatives, shall have access to any books, documents, papers, and records of the contractor which are directly pertinent to a specific program for the purpose of making audits, examination, excerpts and transcriptions.

31. Security Badging

All costs and time associated with obtaining a University security badge for Contractor employees working on campus shall be borne by the Contractor.

SECTION 00 73 01 – SUPPLEMENTARY GENERAL CONDITIONS (D/B/B)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing the contractual requirements of this Project.

1.3 DEFINITIONS (Not Applicable)

1.4 SUPPLEMENTARY GENERAL CONDITIONS

A. The University of Colorado Denver | Anschutz Medical Campus Supplementary General Conditions apply to Contractors Agreement (D/B/B) (SC-6.21) and General Conditions to the Contract (SC-6.23).

B. A copy of the above noted document is attached to the end of this section.

1.5 PROCEDURE (Not applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 73 01

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS

SUPPLEMENTARY GENERAL CONDITIONS

For Design Bid Build Contractor Agreement and General Conditions of the Contract (SC6.21 and SC6.23)
for the Anschutz Medical Campus and Denver Campus

TABLE OF CONTENTS

ARTICLE 25. INSURANCE – Replace Article 25 as follows:

The term University, University of Colorado, University of Colorado Denver, University of Colorado Anschutz Medical Campus, CU Denver, CU Anschutz, Principal Representative, are the interchangeable for this replacement of article 25.

For purposes of this supplement "Contractor" as used herein shall mean, as appropriate to the State Contract form being used, Contractor, Standing Order Contractor, Construction Manager/General Contractor, or Design/Build Entity.

The Contractor shall obtain and maintain, at its own expense and for the duration of the contract including any warranty periods under the Contract are satisfied, the insurance coverages set forth below.

By requiring such insurance, the Principal Representative shall not be deemed or construed to have assessed the risk that may be applicable to the Contractor its agents, representatives, employees or subcontractors under this contract. The insurance requirements herein for this Contract in no way limit the indemnity covenants contained in the Contract. The Principal Representative in no way warrants that the limits contained herein are sufficient to protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, its agents, representatives, employees, or subcontractors. The Contractor shall assess its own risks and if it deems appropriate and/or prudent, maintain higher limits and/or broader coverages. The Contractor is not relieved of any liability or other obligations assumed or pursuant to the Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration, or types.

COVERAGES AND LIMITS OF INSURANCE - - Contractor shall provide coverage with limits of liability not less than those stated below.

1. ***Commercial General Liability – ISO CG 0001 or equivalent. Coverage to include:***
   - Premises and Operations
   - Explosions, Collapse and Underground Hazards
   - Personal / Advertising Injury
   - Products / Completed Operations
   - Liability assumed under an Insured Contract (including defense costs assumed under contract)
   - Independent Contractors
   - Designated Construction Projects(s) General Aggregate Limit, ISO CG 2503 (1997 Edition)
   - Additional Insured—Owners, Lessees or Contractors Endorsement, ISO Form 2010 (2004 Edition or equivalent)
   - Additional Insured—Owners, Lessees or Contractors Endorsement (Completed Operations), ISO CG 2037 (7/2004 Edition or equivalent)
   - **The policy shall be endorsed to include the following additional insured language on the Additional Insured Endorsements specified above: "The Regents of the University of Colorado, a Body Corporate, named as an additional insured with respect to liability and defense of suits arising out of the activities performed by, or on behalf of the Contractor, including completed operations".**
   - Commercial General Liability Completed Operations policies must be kept in effect for up to three (3) years after completion of the project. For buildings with a construction cost greater than $99 million, the Commercial General Liability Completed Operations policies must be kept in effect for up to eight (8) years after the completion of the project.
   - **An umbrella and/or excess liability policy may be used to meet the minimum liability requirements provided that the coverage is written on a "following form" basis.**

Liability Limits	General Aggregate	Products/Completed Operation Aggregate	Each Occurrence	Personal/Advertising Injury
Primary General Liability	$2,000,000	$2,000,000	$1,000,0000	$1,000,000
Umbrella or Excess Liability*	$5,000,000	$5,000,000	$5,000,000	$5,000,000

***Umbrella or Excess Liability does not apply to projects totaling $500, 000 or under.**

The following exclusionary endorsements are prohibited in the CGL policy:

1. Damage to work performed by subcontract/vendor (CG 22-94 or similar);
2. Contractual liability coverage exclusion modifying or deleting the definition of an "insured contract";
3. If applicable to the work to be performed: Residential or multi-family;
4. If applicable to the work to be performed: Exterior insulation finish systems;
5. If applicable to the work to be performed: Subsidence or earth movement.

2. ***Automobile Liability***

Bodily Injury and Property Damage for any owned, hired, and non-owned vehicles used in the performance of this contract

Minimum Limits:

Bodily Injury/Property Damage (Each Accident)	$ 1,000,000

3. ***Workers Compensation***
   - Statutory Benefits (Coverage A)
   - Employers Liability (Coverage B)

   a. Policy shall contain a waiver of subrogation in favor of the Principal Representative.

   b. This requirement shall not apply when a contractor or subcontractor is exempt under Colorado Workers' Compensation Act., **AND** when such contractor or subcontractor executes the appropriate sole proprietor waiver form.

Minimum Limits:

Coverage A (Workers' Compensation)	Statutory
Coverage B (Employers Liability)	
Each accident	$ 100,000
Disease each employee	$ 100,000
Disease policy limit	$ 500,000

4. ***Contractors Pollution Liability***
   - Coverage shall apply to sudden and gradual pollution conditions resulting from the escape of release of smoke, vapors, fumes, acids, alkalis, toxic chemicals, liquids, or gases, natural gas, waste materials, or other irritants, contaminants, or pollutants (including asbestos). Policy shall cover the Contractor's completed operations.
   - If the coverage is written on a claims-made basis, the Contractor warrants that any retroactive date applicable to coverage under the policy precedes the effective date of this Contract; and that continuous coverage will be maintained or an extended discovery period will be exercised for a period of three (3) years beginning from the time that work under this contract is completed.

- **The policy shall be endorsed to include the following as Additional Insureds: The Regents of the University of Colorado, a Body Corporate, named as an additional insured with respect to liability and defense of suits arising out of the activities performed by, or on behalf of the Construction Manager, including completed operations.**
- Endorsements CA9948 and MCS-90 are required on the Automobile Liability Coverage if the Contractor is transporting any type of hazardous materials.
- **Contractors Pollution Liability policies must be kept in effect for up to three (3) years after completion of the project.**

Minimum Limits (Projects at or under $500,000):

Per Loss	$ 1,000,000
Aggregate	$ 1,000,000

Minimum Limits (Projects over $500,000):

Per Loss	$ 2,000,000
Aggregate	$ 2,000,000

5. ***Professional Liability (Errors and Omissions)***
(This Professional Liability requirement applies only to Design/Build Entity SC-8.0 and 9.0.)

- The Contractor shall maintain Errors and Omissions Liability covering negligent acts, errors and/or omissions, including design errors of the Contractor for damage sustained by reason of or in the course of operations under this Contract. The policy/coverages shall be amended to include the following:

  Amendment of any Contractual Liability Exclusion to state: "This exclusion does not apply to any liability of others which you assume under a written contract provided such liability is caused by your negligent acts."

- In the event that any professional liability insurance required by this Contract is written on a claims-made basis, Contractor warrants that any retroactive date under the policy shall precede the effective date of this Contract; and that either continuous coverage will be maintained or an extended discovery period will be exercised for a period of three (3) years beginning at the time work under this Contract is completed.
- Policy shall contain a waiver of subrogation against The Regents of the University of Colorado, a Body Corporate.

Wrongful Act	$2,000,000
General Aggregate	$2,000,000

6. ***Builder's Risk/ Installation Floater***

Unless otherwise provided or instructed by the Principal Representative, the Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the jurisdiction in which the project is located, Builder's Risk Insurance in the amount of the initial contract amount as well as subsequent modifications for the entire project at the site on a replacement cost basis without optional deductibles. This coverage is required for new buildings or additions to existing buildings and for materials and equipment to be installed in existing structures.

- Covered Cause of Loss: Special Form
- Include Theft and Vandalism
- Labor costs to repair damaged work

- Shall be written for 100% of the completed value (replacement cost basis)
- Deductible maximum is $50,000.00
- Waiver of Subrogation is to apply
- The Regents of the University of Colorado, a body corporate, shall be added as **Additional Named Insured on Builders Risk**.

1. Policy must provide coverage from the time any covered property becomes the responsibility of the Contractor, and continue without interruption during construction, renovation, or installation, including any time during which the covered property is being transported to the construction installation site, or awaiting installation, whether on or off site.
2. The Policy shall be maintained, unless otherwise provided in the contract documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made or until no person or entity other than the Principal Representative has insurable interest in the property to be covered, whichever is later.
3. The Builder's Risk insurance shall include interests of the Principal Representative, and if applicable, affiliated or associated entities, the General Contractor, subcontractors and sub-tier contractors in the project.
4. Builders' Risk Coverage shall be on a **Special** Covered Cause of Loss Form and shall include theft, vandalism, malicious mischief, collapse, false-work, temporary buildings and debris removal including demolition, increased cost of construction, architect's fees and expenses, flood (including water damage), earthquake, and if applicable, all below and above ground structures, piping, foundations including underground water and sewer mains, piling including the ground on which the structure rests and excavation, backfilling, filling, and grading. Equipment Breakdown Coverage (a.k.a. Boiler & Machinery) shall be included as required by the Contract Documents or by law, which shall specifically cover insured equipment during installation and testing (including hot testing, where applicable). Other coverages may be required if provided in contract documents.
5. The Builders' Risk shall be written for 100% of the completed value (replacement cost basis) of the work being performed. The Builders' Risk shall include the following provisions:
   a. Replacement Cost Basis - including modification of the valuation clause to cover all costs needed to repair the structure or work (including overhead and profits) and will pay based on the values figured at the time of rebuilding or repairing, not at the time of loss
   b. Modify or delete exclusion pertaining to damage to interior of building caused by an perils insured against are covered; also provide coverage for water damage

   Note, if the addition, or renovation is to an existing building, The Principal Representative requires that the Contractor provide as an option to include the existing building into the Builders' Risk Policy. The Principal Representative shall provide the replacement cost value of the existing building
6. At the option of the Principal Representative, the Principal Representative may include Soft Costs (including Loss of Use)/Delay in Opening Endorsement under the builder's risk policy. The Principal Representative agrees to provide the necessary exposure base information for quotation by the Builder's Risk carrier. The Principal Representative agrees to pay the premium associated with the Soft Costs coverage, the Principal Representative decides to purchase this coverage.
7. The Builders' Risk Policy shall specifically permit occupancy of the building during construction. Partial occupancy or use of the work shall not commence until the insurance company or companies providing insurance have consented to such partial occupancy or use. The Principal Representative and Contractor shall take reasonable steps to obtain consent of the insurance company or companies and delete any provisions with regard to restrictions within any Occupancy Clauses within the Builders' Risk Policy. The Builders' Risk Policy shall remain in force until acceptance of the project by the Principal Representative.
8. The deductible shall not exceed $50,000 and shall be the responsibility of the Contractor except for losses such as flood (not water damage), earthquake, windstorm, tsunami, volcano, etc. Losses in excess of $50,000 insured shall be adjusted in conjunction with the Principal Representative. Any insurance payments/proceeds shall be made payable to the Principal Representative subject to requirements of any applicable mortgagee clause. The Contractor shall pay subcontractors their

just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require subcontractors to make payments to their sub-subcontractors in similar manner.

The Principal Representative shall have the authority to adjust and settle any losses in excess of $50,000 with insurers unless one of the parties in interest shall object in writing within five days after occurrence of loss to the Principal Representative exercise of this power. It is expressly agreed that nothing in this section shall be subject to arbitration and any references to arbitration are expressly deleted.

9. The Contractor is responsible for providing 45 days' notice of cancellation to the Principal Representative. The policy shall contain all generally applicable conditions, definitions, exclusions and endorsements related to the Project.

   If the Contractor does not intend to purchase such Builder's Risk Insurance required by the Contract and with all of the coverages in the amount described above, the Contractor shall so inform the Principal Representative as stated in writing prior to commencement of the work. The Principal Representative may then affect insurance that will protect the interests of the Principal Representative, the General Contractor, Subcontractors and sub-tier contractors in the project. Coverages applying shall be the same as stated above including other coverages that may be required by the Principal Representative. The cost shall be charged to the Contractor. Coverage shall be written for 100% of the completed value of the work being performed, with a deductible not to exceed $50,000 per occurrence for most projects.
   All deductibles will be assumed by the Contractor. Waiver of Subrogation is to apply against all parties named as insureds, but only to the extent the loss is covered, and Beneficial Occupancy Endorsements are to apply.
   If the Principal Representative is damaged by the failure or neglect of the Contractor to purchase or maintain insurance as described above, without so notifying the Principal Representative, then the Contractor shall bear all reasonable costs properly attributable thereto.

ADDITIONAL INSURANCE REQUIREMENTS

1. All insurers must be licensed or approved to do business within the State of Colorado, and unless otherwise specified, all policies must be written on a per occurrence basis.
2. Contractor's insurance carrier should possess a minimum A.M. Best's Insurance Guide rating of A- VI.
3. On insurance policies where the Principal Representative are named as additional insureds, the Principal Representative shall be additional insureds to the full limits of liability purchased by the Contractor even if those limits of liability are in excess of those required by this Contract.
4. Contractor shall furnish the Principal Representative with certificates of insurance (ACORD form or equivalent approved by the Principal Representative) as required by this Contract. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf.
   All certificates and any required endorsements are to be received and approved by the Principal Representative before work commences. Each insurance policy required by this Contract must be in effect at or prior to commencement of work under this Contract and remain in effect for the duration of the project. Failure to maintain the insurance policies as required by this Contract or to provide evidence of renewal is a material breach of contract.
5. Upon request by the Principal Representative, Contractor must provide a copy of the actual insurance policy effecting coverage(s) required by the contract.
6. The Contractor's insurance coverage shall be primary insurance and non-contributory with respect to all other available resources.
7. The Contractor shall advise the Principal Representative in the event any general aggregate or other aggregate limits are reduced below the required per occurrence limit. At their own expense, the Contractor will reinstate the aggregate limits to comply with the minimum requirements and shall furnish to the Principal Representative a new certificate of insurance showing such coverage is in force.

8. Provide a minimum of thirty (30) days advance written notice to the Principal Representative for cancellation, non-renewal, or material changes to policies required under the Contract (45 days for builders' risk coverage.
9. Certificate Holder: The Regents of the University of Colorado, Project Management, 1945 North Wheeling Street, Campus Mail stop F-418, Aurora, CO 80045.

Failure of the Contractor to fully comply with these requirements during the term of the Contract may be considered a material breach of contract and may be cause for immediate termination of the Contract at the option of the Principal Representative. The Principal Representative reserves the right to negotiate additional specific insurance requirements at the time of the contract award.

Subcontractors
Contractor's certificate(s) shall include all subcontractors as additional insureds under its policies **or** subcontractors shall maintain separate insurance as determined by the Contractor, however, subcontractor's limits of liability shall not be less than $1,000,000 per occurrence / $2,000,000 aggregate.

Non-Waiver
The parties hereto understand and agree that The Principal Representative is relying on, and does not waive or intend to waive by any provision of this Contract, the monetary limitations or any other rights, immunities, and protections provided by the Colorado Governmental Immunity Act, et seq., as from time to time amended, or otherwise available to the Principal Representative or its officers, employees, agents, and volunteers.

Mutual Cooperation
The Principal Representative and Contractor shall cooperate with each other in the collection of any insurance proceeds which may be payable in the event of any loss, including the execution and delivery of any proof of loss or other actions required to effect recovery.

(Revised 7-21-11)

ARTICLE 41. COMPLETION, FINAL INSPECTION, ACCEPTANCE AND SETTLEMENT – Add the following

Contractor will be required to complete items on University of Colorado Denver │ Anschutz Medical Campus Supplemental Building / Project Acceptance List and attend walk-thrus and meetings necessary to complete the list, working through the university Project Manager (use University of Colorado Denver │ Anschutz Medical Campus Supplemental / Project Acceptance List).

ARTICLE 52. SPECIAL PROVISIONS -Add the following:

M: UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS POLICY ON SEXUAL HARASSMENT

1) The Contractor shall vigorously pursue to the greatest extent possible, adherence to the University of Colorado Denver | Anschutz Medical Campus Policy on Sexual Harassment and also require all employees, and employees of all subcontractors of any kind, working on this project to adhere to this Policy.

2) Statement of Policy: It is the policy of the University of Colorado Denver to maintain the community as a place of work, study, and residence free of sexual harassment or exploitation of students, faculty, staff, and administrators. Sexual harassment is prohibited on campus and in university programs. The university is committed to taking appropriate action against any of its officials, employees or students who violate the policy prohibiting sexual harassment.

3) Definition of Sexual Harassment: For purposes of this Policy, sexual harassment is defined as conduct which is unwelcome and consists of:

1. sexual advances; 2. requests for sexual favors; or 3. other verbal or physical conduct of a sexual nature when submission to such conduct is made either explicitly or implicitly a term or condition of an individual's employment or academic decisions affecting the individual; or when such conduct has the purpose or effect, of unreasonably interfering with an individual's work or academic performance by creating an intimidating, hostile, or offensive working or educational environment.

Conduct prohibited under this policy may occur between persons of the same sex or of different sexes and may manifest itself in different ways. For example, sexual harassment may be as undisguised as a direct solicitation of sexual favors, or arise from behavior which has the effect of creating an intimidating, hostile, or offensive educational or working environment. In this regard, the following types of acts, if pervasive and continuous, are more likely than not to be considered sexual harassment: unwelcome physical contact, sexual remarks about a person's clothing, body, or sexual relations, conversation of a sexual nature or similar jokes and stories, and the display of sexually explicit materials in the workplace or their use in the classroom without defensible educational purpose.

4) Consequence of Sexual Offenses: The university may require the Contractor to remove from university property any individual or individuals who violate the policy prohibiting sexual harassment.

ARTICLE 53. MISCELLANEOUS PROVISIONS -Add the following:

L. All costs and time associated with obtaining a University security badge for Contractor employees working on campus shall be borne by the Contractor.

UNIVERSITY OF COLORADO DENVER | ANSCHUTZ MEDICAL CAMPUS
SUPPLEMENTARY GENERAL CONDITIONS
For Design Bid Build Contractor Agreement and General Conditions of the Contract (SC6.21 and SC6.23)

APPENDIX A

Tax Information:

1. Certificate of Exemption for State Sales/Use Tax, dated August 25, 2017
2. Sales Tax Exemption Certificate – Multi-Jurisdiction dated September 4, 2018
2. City of Aurora Sales and Use Tax Exemption, dated March 12, 2001
3. City of County of Denver Tax Confirming Exemption Status, dated November 5, 1999
4. State of Colorado Letter Confirming Adams County, RTD, Stadium, and Cultural Tax Exemptions, dated April 7, 2006
5. Colorado Department of Revenue - Contractor Application for Exemption Certification

DR 0160 (02/16/11)
COLORADO DEPARTMENT OF REVENUE
DENVER CO 80261-0013

CERTIFICATE OF EXEMPTION FOR STATE SALES/USE TAX ONLY

THIS LICENSE IS NOT TRANSFERABLE

USE ACCOUNT NUMBER for all references	LIABILITY INFORMATION	ISSUE DATE
09802565	G 010180	Aug 25 2017

STATE OF COLORADO/ OFFICE OF STATE CONTROLLER
ATTN: OFFICE OF UNIVERSITY CONTROLLER
1800 N GRANT ST STE 600
DENVER CO 80203-1148

Executive Director
Department of Revenue

DR 0563 (08/30/13)
COLORADO DEPARTMENT OF REVENUE
Denver CO 80261-0013

130563 19999

Sales Tax Exemption Certificate
Multi - Jurisdiction

See page 2 for instructions

Last Name or Business Name	First Name	Middle Initial

Address		

City	State	ZIP

I Certify That

Name of Firm (Buyer)
The Regents of University of Colorado

Address
1800 Grant Street, Suite 600

City	State	ZIP
Denver	CO	80203

Qualifies As (Check each applicable item)

☐ Wholesaler ☐ Retailer ☐ Manufacturer ☐ Charitable or Religious

☒ Political Subdivision or Governmental Agency ☐ Other (Specify)

If Other, specify here

1) and is registered with the below listed states and cities within which your firm would deliver purchases to us which are for resale or lease by us in the normal course of our business which is Institution of Higher Education or

2) that such purchases are exempt from payment of sales or use tax in such states and cities because our buyer is:

☒ Political Subdivision or Governmental Agency ☐ Charitable or Religious ☐ Otherwise Exempt By Statute (Specify)

If Otherwise Exempt By Statue, specify here

City or State	State Registration or ID Number	City or State	State Registration or ID Number
City of Aurora	98-00799-0000	Colorado (Boulder campus)	98-02915-0000
Colorado	98-02565-0000	Texas	32002730391

If the list of states and cities is more than six(6), attach a list to this certificate.
I further certify that if any property so purchased tax free is used or consumed by the firm as to make it subject to a Sale or Use Tax we will pay the tax due direct to proper taxing authority when state law so provides or inform the seller for added tax billing. This certificate shall be part of each order which we may hereafter give to you, unless otherwise specified, and shall be called until canceled by us in writing or revoked by the city or state.

General Description of products to be purchased from seller

Under penalties of perjury, I swear or affirm that the information on this form is true and correct as to every material matter.

Authorized Signature *(owner, Partner or Corporate Officer)*	Title	Date (MM/DD/YY)
Robert C Kuehn	Associate Vice President/University Controller	9/4/18

FINANCE DEPARTMENT

Administration
1470 South Havana Street
Aurora, Colorado 80012
303-739-7055
FAX: 303-739-7068

March 12, 2001

Wayne F. Henderson
Vice Chancellor for Administration and Finance
University of Colorado Health Sciences Center
Fitzsimons, Building 500, Room C1003
P.O. Box 6508
Aurora, Colorado 80045-0508

RE: Letter of Commitment

Dear Mr. Henderson:

I am in receipt of your letter dated February 27, 2001, requesting that I issue a letter of commitment to the University of Colorado Health Sciences Center ("UCHSC") pursuant to *City Code Section 130-63(c)*. It is my understanding that UCHSC is part and parcel of the University of Colorado, a public institution of higher education of the State of Colorado. *§ 23-20-101, et seq., C.R.S.* You have asked for some assurance that UCHSC is exempt from the payment of City sales and use tax, as well as the employer portion of the City occupational privilege tax.

City Code Section 130-157(1) exempts all sales of tangible personal property and taxable services to the various political subdivisions of this state from imposition of City sales tax. Identical exemptions exist in both the City Use Tax ordinance (*City Code § 130-198(5)*) and the City Employer Occupational Privilege Tax ordinance (*City Code § 130-405(1)*). Accordingly, UCHSC falls squarely within each of these three exemptions.

It should be noted, however, that these exemptions do not extend to the collection of City tax. For instance, UCHSC must collect, report, and remit City sales tax on any retail sale of tangible personal property or taxable services it makes to a non-exempt third party. *City Code § 130-160.* Likewise, UCHSC

must also collect, report, and remit the employee portion of the City occupational privilege tax for each person it employs within the City for any period of time within a calendar month sufficient to receive no less than $250.00 as compensation for such employment. *City Code § 130-464.*

With respect to the deposit and ultimate payment of City use tax on construction materials, it is the longstanding policy of the City that the party who contracts for and directs and controls the construction of building improvements is liable for such tax. *See Fifteenth Street Investment Co. v. People, 102 Colo. 571, 81 P.2d 764 (1938).* Under the circumstances described in your request, it is UCHSC, and not its contractors, upon whom sole liability for the payment of City use tax would rest. Because UCHSC is an exempt entity, no use tax is due and owing on the purchase and subsequent use of construction materials for the development of UCHSC's property at the Fitzsimons site.

With regard to your additional requests, the City has no objection if UCHSC's contractors wish to use this letter to present to City building officials and third-party retailers as evidence of UCHSC's tax exemption. As for any future revocation of this letter, unless the status of UCHSC as a political subdivision changes, the various City tax exemptions which UCHSC is entitled to claim cannot be lawfully repealed without the prior approval of the City's voters. *See Colo. Const. Art. X, § 20(4)(a).* Therefore, the City believes UCHSC will be adequately informed in the event that the City decides to seek approval for any change in its tax laws that would impact UCHSC's tax-exempt status.

Very truly yours,

John Gross
Director of Finance

Department of Finance
Treasury Division
Tax Compliance - Audit Unit

201 W Colfax Ave #1009
Denver, CO 80202
fax: 720- 913-9455
www.denvergov.org/treasury

DENVER
THE MILE HIGH CITY

February 19, 2014

University of Colorado
Procurement Service Center
1800 Grant Street, Suite 500
Denver, CO 80203

Ladies/Gentlemen:

The above named entity is exempt from the Denver sales tax per Sec. 53-26(1) of the City Retail Sales Tax Article:

Sec. 53-26 (1) Exemptions

There shall be exempt from taxation under the provisions of this Article the following: (1) All sales to the United States Government, to the State, its departments and institutions and the political subdivisions thereof, only when purchased in their governmental capacities.

To qualify for the exemption, purchases must be billed direct to the organization, and payment made from funds of the organization.

The exemption does not extend to construction contractors who may perform contracts for you; they are the consumer of all property purchased and used in the performance or contracts for others. Nor does the exemption apply to purchases by employees or members for their own personal use.

You may reproduce this letter to furnish to suppliers as needed.

Sincerely,

Donald Korte, Audit Manager
Tax Compliance/Audit Section
720-913-9339

STATE OF COLORADO

TAXPAYER SERVICE DIVISION
Department of Revenue

1375 Sherman Street
Denver, Colorado 80261

Michael J. Barden
University of Colorado at Denver and Health Sciences Center(UCDHSC)
Building 500, Mail Stop F418
P.O. Box 6508
Aurora CO 80045

April 7, 2006

Dear Mr. Barden:

This is in response to your letter of March 1, 2006, to Bruce Nelson of the Department of Revenue regarding sales tax exemption from county and special district sales taxes for UCDHSC construction projects at the Fitzsimons campus. Mr. Nelson has left the Department, so I am responding to your inquiry.

In regards to Adams County sales and use tax, the sales tax is collected by the Department of Revenue, not the city of Aurora. Use tax on building materials is collected by the county when issuing building permits. Under 29-2-105(d), 39-26-708(1)(a) and 39-26-708(2)(a), C.R.S., UCDHSC and its contractors and sub-contractors are exempt from county sales and use tax on construction and building materials for State/UCDHSC owned real property.

In regards to special district sales and use taxes, UCDHSC and its contractors and sub-contractors are exempt from sales and use tax pursuant to the exemptions granted in 39-26-708(1)(a) and 39-26-708(2)(a), C.R.S., for the Regional Transportation District under 32-9-119(2)(c)(II), C.R.S, for the Scientific and Cultural District under 32-13-107(2), C.R.S, and for the Metropolitan Football Stadium District under 32-15-110(2)(a), C.R.S.

Additionally, for construction projects in the City and County of Denver, UCDHSC and its contractors and sub-contractors are exempt from the aforementioned special district sales and use taxes, as well as state sales and use tax.

Should you have additional questions regarding these matters, feel free to contact me.

Respectfully,

Steve Asbell

Steve Asbell
Taxpayer Service Policy Group
Colorado Dept of Revenue
Ph:303.866.3889 email: sasbell@spike.dor.state.co.us

DO NOT SEND

DR 0172 (05/01/18)
COLORADO DEPARTMENT OF REVENUE
Denver CO 80261 - 0009
(303) 238-SERV (7378)

Special Notice

Purpose of this application

The exemption certificate for which you are applying must be used only for the purpose of purchasing construction and building materials for the exempt project described below. This exemption does not include or apply to the purchase or rental of equipment, supplies, and materials which are purchased, rented, or consumed by the contractor and which do not become a part of the structure, highway, road, street, or other public works **owned** and **used** by the exempt organization.

Any unauthorized use of the exemption certificate will result in revocation of your exemption certificate and other penalties provided by law.

A separate certificate is required for each project.

Colorado Withholding Account Number

A Colorado Account Number (CAN) should be provided in this field. Applications that are left blank or list N/A will not be processed and will be returned.

Subsidiary:
This box is marked when a subsidiary is using the parents withholding account number (only when it does not have its own.) Provide the parents CAN.

Subcontractor:
This box is marked when a contractor does not have employees of their own and outsources their employees through a subcontractor. List the subcontractor or subcontractors name and CAN(s).

Staffing Agency:
This box is marked when a contractor does not have employees of their own and outsources their employees through a staffing agency. Provide the Staffing Agency's name and CAN.

No employees/no subcontractors:
For contractors with no employees, no subcontractors/ staffing agencies:

Write no employees in the (CAN) box and provide explanation. For example, I have no employees or subcontractors and perform all of the work myself.

Subcontractors:
Subcontractors will not be issued Certificates of Exemption by the Department of Revenue. Upon receipt of the Certificate, the prime contractor should make a copy for each subcontractor involved in the project and complete it by filling in the subcontractor's name and address and signing it. The original Certificate should always be retained by the prime contractor. Copies of all Certificates that the prime contractor issued to subcontractors should be kept at the prime contractor's place of business for a minimum of three years and be available for inspection in the event of an audit.

See FYI Sales 95 for information about qualifying affordable housing projects.

To avoid a returned application ensure you have done the following:

- ☐ Accurately completed all applicable boxes of the form.
- ☐ Provided a copy of the Contract or agreement page. The Contract or Agreement page lists the type and scope of work.
- ☐ Bid amount on Contract or Agreement page matches the amount listed on the application (to the penny).
- ☐ Contract or Agreement page contains the signatures of the contracting parties.
- ☐ The form DR0172 (application) is signed.
- ☐ The exempt organizations number was provided and is correct.

140172 19999

DR 0172 (05/01/18)
COLORADO DEPARTMENT OF REVENUE
Denver CO 80261 - 0009
(303) 238-SERV (7378)

Contractor Application for Exemption Certificate

This exemption does not include or apply to the purchase or rental of equipment, supplies, and materials which are purchased, rented, or consumed by the contractor and which do not become a part of the structure, highway, road, street, or other public works **owned** and **used** by the exempt organization.

Any unauthorized use of the exemption certificate will result in revocation of your exemption certificate and other penalties provided by law. A separate certificate is required for each contract.

Send completed forms to: Colorado Department of Revenue, Denver, CO 80261-0009
Failure to accurately complete all boxes of the form or provide all supporting documentation will cause the application to be denied.

For Department Use Only. Do not write in this section.

Contractor/Account No.	Period (MM/YY-MM/YY)
89-	

Must be completed by applicant

Contractor Information

Trade name/DBA			
Owner, partner or corporate last name	First Name		Middle Initial
Mailing Address	City	State	Zip
E-Mail Address	FEIN	Bid amount for your contract (Must match to the penny) $	
Fax number	Business Phone number		
Colorado withholding tax account number (See instructions)	☐ Subsidiary ☐ Subcontractors ☐ Staffing Agency ☐ No employees/subcontractors (see below)		
No Employees/Subcontractors. (Provide explanation or attach a letter of explanation).			

Exemption Information

Copies of contract or agreement page, identifying the contracting parties, bid amount, type of work, and signatures of contracting parties **must** be attached

Name of exempt organization (as show on contract)		Exempt organization's number **98**	
Address of exempt organization	City	State	Zip
Principal contact at exempt organization-Last Name	First Name		Middle Initial
Housing Authority (if applicable)	Name of Project (if applicable)		
Owner of the Project (if applicable)			
Physical location of project site (give actual address when applicable and Cities and/or County (ies) where project is located)			
City	State	Zip	Principal contact's telephone number
Scheduled construction start date (MM/DD/YY)	Estimated completion date (MM/DD/YY)		

I declare under penalty of perjury in the second degree that the statements made in this application are true and complete to the best of my knowledge.

Signature of the business owner, partner or corporate officer	Title of corporate officer	Date (MM/DD/YY)

SECTION 00 73 46 - WAGE DETERMINATION SCHEDULE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY (Not Applicable)

1.3 DEFINITIONS (Not Applicable)

1.4 PROCEDURE

A. DAVIS-BACON WAGE DETERMINATIONS

1. Coordinate with the University Project Manager to determine if applicable.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 73 46

SECTION 00 73 80 – SALES TAX

PART 1 - GENERAL

1.1 RELATED DOCUMENTS (Not Applicable)

1.2 SUMMARY

A. This Section includes administrative documents related to sales tax exemption for construction material purchases.

1.3 DEFINITIONS (Not Applicable)

1.4 DOCUMENTS

A. Tax Exempt Status of University of Colorado, dated August 25, 2017

B. City of Aurora Sales and Use Tax Exemption, dated March 12, 2001

C. City of County of Denver Tax Confirming Exemption Status, dated November 5, 1999

D. State of Colorado Letter Confirming Adams County, RTD, Stadium, and Cultural Tax Exemptions, dated April 7, 2006

E. Colorado Department of Revenue - Contractor Application for Exemption Certification

F. Copies of the above noted documents are attached to the end of this section.

1.5 PROCEDURE

A. General Contractor must apply for a sales tax exemption certificate through the Colorado Department of Revenue using the “Contractor Application For Exemption Certificate.”

1. Form can be downloaded from the Colorado Department of Revenue website: https://www.colorado.gov/pacific/sites/default/files/DR0172.pdf

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 73 80

DR 0160 (02/16/11)
COLORADO DEPARTMENT OF REVENUE
DENVER CO 80261-0013

CERTIFICATE OF EXEMPTION FOR STATE SALES/USE TAX ONLY

THIS LICENSE IS NOT TRANSFERABLE

USE ACCOUNT NUMBER for all references	LIABILITY INFORMATION	ISSUE DATE
09802565	G 010180	Aug 25 2017

STATE OF COLORADO/ OFFICE OF STATE CONTROLLER
ATTN: OFFICE OF UNIVERSITY CONTROLLER
1800 N GRANT ST STE 600
DENVER CO 80203-1148

Executive Director
Department of Revenue

DR 0563 (08/30/13)
COLORADO DEPARTMENT OF REVENUE
Denver CO 80261-0013

130563 19999

Sales Tax Exemption Certificate
Multi - Jurisdiction

See page 2 for instructions

Last Name or Business Name	First Name	Middle Initial

Address		

City	State	ZIP

I Certify That

Name of Firm (Buyer)
The Regents of University of Colorado

Address
1800 Grant Street, Suite 600

City	State	ZIP
Denver	CO	80203

Qualifies As (Check each applicable item)

☐ Wholesaler ☐ Retailer ☐ Manufacturer ☐ Charitable or Religious

☒ Political Subdivision or Governmental Agency ☐ Other (Specify)

If Other, specify here

1) and is registered with the below listed states and cities within which your firm would deliver purchases to us which are for resale or lease by us in the normal course of our business which is Institution of Higher Education or

2) that such purchases are exempt from payment of sales or use tax in such states and cities because our buyer is:

☒ Political Subdivision or Governmental Agency ☐ Charitable or Religious ☐ Otherwise Exempt By Statute (Specify)

If Otherwise Exempt By Statue, specify here

City or State	State Registration or ID Number	City or State	State Registration or ID Number
City of Aurora	98-00799-0000	Colorado (Boulder campus)	98-02915-0000
Colorado	98-02565-0000	Texas	32002730391

If the list of states and cities is more than six(6), attach a list to this certificate.
I further certify that if any property so purchased tax free is used or consumed by the firm as to make it subject to a Sale or Use Tax we will pay the tax due direct to proper taxing authority when state law so provides or inform the seller for added tax billing. This certificate shall be part of each order which we may hereafter give to you, unless otherwise specified, and shall be called until canceled by us in writing or revoked by the city or state.

General Description of products to be purchased from seller

Under penalties of perjury, I swear or affirm that the information on this form is true and correct as to every material matter.

Authorized Signature *(owner, Partner or Corporate Officer)*	Title	Date (MM/DD/YY)
Robert C Kuehn	Associate Vice President/University Controller	9/4/18

FINANCE DEPARTMENT

Administration
1470 South Havana Street
Aurora, Colorado 80012
303-739-7055
FAX: 303-739-7068

March 12, 2001

Wayne F. Henderson
Vice Chancellor for Administration and Finance
University of Colorado Health Sciences Center
Fitzsimons, Building 500, Room C1003
P.O. Box 6508
Aurora, Colorado 80045-0508

RE: Letter of Commitment

Dear Mr. Henderson:

I am in receipt of your letter dated February 27, 2001, requesting that I issue a letter of commitment to the University of Colorado Health Sciences Center ("UCHSC") pursuant to *City Code Section 130-63(c)*. It is my understanding that UCHSC is part and parcel of the University of Colorado, a public institution of higher education of the State of Colorado. *§ 23-20-101, et seq., C.R.S.* You have asked for some assurance that UCHSC is exempt from the payment of City sales and use tax, as well as the employer portion of the City occupational privilege tax.

City Code Section 130-157(1) exempts all sales of tangible personal property and taxable services to the various political subdivisions of this state from imposition of City sales tax. Identical exemptions exist in both the City Use Tax ordinance (*City Code § 130-198(5)*) and the City Employer Occupational Privilege Tax ordinance (*City Code § 130-405(1)*). Accordingly, UCHSC falls squarely within each of these three exemptions.

It should be noted, however, that these exemptions do not extend to the collection of City tax. For instance, UCHSC must collect, report, and remit City sales tax on any retail sale of tangible personal property or taxable services it makes to a non-exempt third party. *City Code § 130-160.* Likewise, UCHSC

must also collect, report, and remit the employee portion of the City occupational privilege tax for each person it employs within the City for any period of time within a calendar month sufficient to receive no less than $250.00 as compensation for such employment. *City Code § 130-464.*

With respect to the deposit and ultimate payment of City use tax on construction materials, it is the longstanding policy of the City that the party who contracts for and directs and controls the construction of building improvements is liable for such tax. *See Fifteenth Street Investment Co. v. People, 102 Colo. 571, 81 P.2d 764 (1938).* Under the circumstances described in your request, it is UCHSC, and not its contractors, upon whom sole liability for the payment of City use tax would rest. Because UCHSC is an exempt entity, no use tax is due and owing on the purchase and subsequent use of construction materials for the development of UCHSC's property at the Fitzsimons site.

With regard to your additional requests, the City has no objection if UCHSC's contractors wish to use this letter to present to City building officials and third-party retailers as evidence of UCHSC's tax exemption. As for any future revocation of this letter, unless the status of UCHSC as a political subdivision changes, the various City tax exemptions which UCHSC is entitled to claim cannot be lawfully repealed without the prior approval of the City's voters. *See Colo. Const. Art. X, § 20(4)(a).* Therefore, the City believes UCHSC will be adequately informed in the event that the City decides to seek approval for any change in its tax laws that would impact UCHSC's tax-exempt status.

Very truly yours,

John Gross
Director of Finance

Department of Finance
Treasury Division
Tax Compliance - Audit Unit

201 W Colfax Ave #1009
Denver, CO 80202
fax: 720- 913-9455
www.denvergov.org/treasury

DENVER
THE MILE HIGH CITY

February 19, 2014

University of Colorado
Procurement Service Center
1800 Grant Street, Suite 500
Denver, CO 80203

Ladies/Gentlemen:

The above named entity is exempt from the Denver sales tax per Sec. 53-26(1) of the City Retail Sales Tax Article:

Sec. 53-26 (1) Exemptions

There shall be exempt from taxation under the provisions of this Article the following: (1) All sales to the United States Government, to the State, its departments and institutions and the political subdivisions thereof, only when purchased in their governmental capacities.

To qualify for the exemption, purchases must be billed direct to the organization, and payment made from funds of the organization.

The exemption does not extend to construction contractors who may perform contracts for you; they are the consumer of all property purchased and used in the performance or contracts for others. Nor does the exemption apply to purchases by employees or members for their own personal use.

You may reproduce this letter to furnish to suppliers as needed.

Sincerely,

Donald Korte, Audit Manager
Tax Compliance/Audit Section
720-913-9339

STATE OF COLORADO

TAXPAYER SERVICE DIVISION
Department of Revenue

1375 Sherman Street
Denver, Colorado 80261

Michael J. Barden
University of Colorado at Denver and Health Sciences Center(UCDHSC)
Building 500, Mail Stop F418
P.O. Box 6508
Aurora CO 80045

April 7, 2006

Dear Mr. Barden:

This is in response to your letter of March 1, 2006, to Bruce Nelson of the Department of Revenue regarding sales tax exemption from county and special district sales taxes for UCDHSC construction projects at the Fitzsimons campus. Mr. Nelson has left the Department, so I am responding to your inquiry.

In regards to Adams County sales and use tax, the sales tax is collected by the Department of Revenue, not the city of Aurora. Use tax on building materials is collected by the county when issuing building permits. Under 29-2-105(d), 39-26-708(1)(a) and 39-26-708(2)(a), C.R.S., UCDHSC and its contractors and sub-contractors are exempt from county sales and use tax on construction and building materials for State/UCDHSC owned real property.

In regards to special district sales and use taxes, UCDHSC and its contractors and sub-contractors are exempt from sales and use tax pursuant to the exemptions granted in 39-26-708(1)(a) and 39-26-708(2)(a), C.R.S., for the Regional Transportation District under 32-9-119(2)(c)(II), C.R.S, for the Scientific and Cultural District under 32-13-107(2), C.R.S, and for the Metropolitan Football Stadium District under 32-15-110(2)(a), C.R.S.

Additionally, for construction projects in the City and County of Denver, UCDHSC and its contractors and sub-contractors are exempt from the aforementioned special district sales and use taxes, as well as state sales and use tax.

Should you have additional questions regarding these matters, feel free to contact me.

Respectfully,

Steve Asbell

Steve Asbell
Taxpayer Service Policy Group
Colorado Dept of Revenue
Ph:303.866.3889 email: sasbell@spike.dor.state.co.us

DO NOT SEND

DR 0172 (05/01/18)
COLORADO DEPARTMENT OF REVENUE
Denver CO 80261 - 0009
(303) 238-SERV (7378)

Special Notice

Purpose of this application

The exemption certificate for which you are applying must be used only for the purpose of purchasing construction and building materials for the exempt project described below. This exemption does not include or apply to the purchase or rental of equipment, supplies, and materials which are purchased, rented, or consumed by the contractor and which do not become a part of the structure, highway, road, street, or other public works **owned** and **used** by the exempt organization.

Any unauthorized use of the exemption certificate will result in revocation of your exemption certificate and other penalties provided by law.

A separate certificate is required for each project.

Colorado Withholding Account Number

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Subcontractor:
This box is marked when a contractor does not have employees of their own and outsources their employees through a subcontractor. List the subcontractor or subcontractors name and CAN(s).

Staffing Agency:
This box is marked when a contractor does not have employees of their own and outsources their employees through a staffing agency. Provide the Staffing Agency's name and CAN.

No employees/no subcontractors:
For contractors with no employees, no subcontractors/ staffing agencies:

Write no employees in the (CAN) box and provide explanation. For example, I have no employees or subcontractors and perform all of the work myself.

Subcontractors:
Subcontractors will not be issued Certificates of Exemption by the Department of Revenue. Upon receipt of the Certificate, the prime contractor should make a copy for each subcontractor involved in the project and complete it by filling in the subcontractor's name and address and signing it. The original Certificate should always be retained by the prime contractor. Copies of all Certificates that the prime contractor issued to subcontractors should be kept at the prime contractor's place of business for a minimum of three years and be available for inspection in the event of an audit.

See FYI Sales 95 for information about qualifying affordable housing projects.

To avoid a returned application ensure you have done the following:

- ☐ Accurately completed all applicable boxes of the form.
- ☐ Provided a copy of the Contract or agreement page. The Contract or Agreement page lists the type and scope of work.
- ☐ Bid amount on Contract or Agreement page matches the amount listed on the application (to the penny).
- ☐ Contract or Agreement page contains the signatures of the contracting parties.
- ☐ The form DR0172 (application) is signed.
- ☐ The exempt organizations number was provided and is correct.

140172 19999

DR 0172 (05/01/18)
COLORADO DEPARTMENT OF REVENUE
Denver CO 80261 - 0009
(303) 238-SERV (7378)

Contractor Application for Exemption Certificate

This exemption does not include or apply to the purchase or rental of equipment, supplies, and materials which are purchased, rented, or consumed by the contractor and which do not become a part of the structure, highway, road, street, or other public works **owned** and **used** by the exempt organization.

Any unauthorized use of the exemption certificate will result in revocation of your exemption certificate and other penalties provided by law. A separate certificate is required for each contract.

Send completed forms to: Colorado Department of Revenue, Denver, CO 80261-0009
Failure to accurately complete all boxes of the form or provide all supporting documentation will cause the application to be denied.

For Department Use Only. Do not write in this section.

Contractor/Account No.	Period (MM/YY-MM/YY)
89-	

Must be completed by applicant

Contractor Information

Trade name/DBA			
Owner, partner or corporate last name	First Name		Middle Initial
Mailing Address	City	State	Zip
E-Mail Address	FEIN	Bid amount for your contract (Must match to the penny) $	
Fax number	Business Phone number		
Colorado withholding tax account number (See instructions)	☐ Subsidiary ☐ Subcontractors ☐ Staffing Agency ☐ No employees/subcontractors (see below)		
No Employees/Subcontractors. (Provide explanation or attach a letter of explanation).			

Exemption Information

Copies of contract or agreement page, identifying the contracting parties, bid amount, type of work, and signatures of contracting parties **must** be attached

Name of exempt organization (as show on contract)		Exempt organization's number **98**	
Address of exempt organization	City	State	Zip
Principal contact at exempt organization-Last Name	First Name		Middle Initial
Housing Authority (if applicable)	Name of Project (if applicable)		
Owner of the Project (if applicable)			
Physical location of project site (give actual address when applicable and Cities and/or County (ies) where project is located)			
City	State	Zip	Principal contact's telephone number
Scheduled construction start date (MM/DD/YY)	Estimated completion date (MM/DD/YY)		

I declare under penalty of perjury in the second degree that the statements made in this application are true and complete to the best of my knowledge.

Signature of the business owner, partner or corporate officer	Title of corporate officer	Date (MM/DD/YY)

SECTION 01 10 00

SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work by University.
4. Work under separate contracts.
5. University-furnished and installed products.
6. University-furnished, Contractor-installed products.
7. Access to site.
8. Coordination with occupants.
9. Work restrictions.
10. Specification and drawing conventions.

B. Related Requirements:

1. Section 01 35 46 “Indoor Air Quality Procedures” for requirements and procedures related to maintaining air quality in adjacent occupied spaces and buildings.
2. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of University's facilities and for the provision of temporary construction barriers and dust partitions.

1.3 PROJECT INFORMATION

A. Project Identification: **PN23-110899 / Perinatal Power HVAC Boiler Upgrades**.

1. Project Location: **University of Colorado Anschutz Medical Campus; 13243 East 23rd Street, Aurora, CO 80045**.

B. Principal Representation: University of Colorado Denver.

1. University's Representative: **Robert Holzwarth – Project Manager** **robert.holzwarth@cuanschutz.edu** **720-854-4664**.

C. Architect/Engineer: **Karena Broman-Ballas MEP Engineering, Inc.** **karena@mep-eng.com** **303-936-1633**.

1.4 WORK BY UNIVERSITY

A. General: Cooperate fully with University so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by University. Coordinate the Work of this Contract with work performed by University.

1.5 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

1.6 UNIVERSITY-FURNISHED AND INSTALLED PRODUCTS

A. University will furnish certain items of equipment/furnishings as shown on the Drawings. Contractor will be responsible for coordinating their work to accommodate these items including, but not limited to, physical space fit, utility connections and rough-in, power wiring and electrical characteristics.

B. Include in Project scheduling the latest times when information for such items is required and so notify the University in writing.

1.7 UNIVERSITY-FURNISHED, CONTRACTOR-INSTALLED PRODUCTS

A. The University will furnish certain items delivered to the jobsite as shown on the drawings. Contractor will receive, unload, move, set in position, anchor and connect such items and put them into operating condition.

B. The Contractor will be responsible for coordinating their work to accommodate these items including, but not limited to, physical space fit, utility connections and rough-in, power wiring and electrical characteristics.

C. Include in Project scheduling the latest times when information for such items is required and so notify the University in writing.

D. Cooperate with University in scheduling the delivery of these items and be responsible for accommodating their storage and protection in the building and their replacement or repair due to damage as a result of Contractor’s operations.

1.8 ACCESS TO SITE

A. General: Contractor shall have limited and restricted use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Adjust means and methods of construction based on site limits and restrictions.

2. Locate staging areas only where permitted by University.
3. As part of this Project, replace damaged lawns, sprinkler systems, sidewalks and any other existing site improvements within staging area and access ways.

C. Construction Access and Travel:

1. Use only those entrances, exits, and travel ways on campus roads and within the building designated by University. Contractor's personnel are not permitted in non-designated areas of University's existing facilities. Use only designated travel ways for transporting demolition materials, new construction materials, tools and equipment.

2. Use of other than designated travel ways on campus roads and within existing buildings requires a minimum of 20 business days prior approval by University.

    a. Request variations to traffic flow including temporary fire lane, parking lot, sidewalk and road closures, regulatory signage, and traffic control devices in accordance with University "Procedure for Approval of Regulatory Signage, Traffic Control Devices and for Street Closures at the Anschutz Medical Campus" and "AMC Campus Street and Parking Lot Closure Request" available through University Project Manager.

3. Access to the site will be as permitted by the University. Prearrange delivery and use of cranes, heavy trucks and other heavy equipment at least 72 hours prior to need through the University's Project Manager and University Police.

4. Maintain access to fire lanes and campus operations at all times. Provide flag personnel during the ingress or egress of large equipment.

    a. When fire lanes and/or access way must be temporarily disrupted notify University Police and University Parking and Transportation at least 20 business days in advance and reconfirm 72 hours in advance through the University's Project Manager.

5. Arrange for and obtain all necessary permits from City of Aurora for any disruption to or temporary closures of public city streets. Coordinate procurement of permits with Anschutz Medical Campus Liaison and University Project Manager.

D. Construction Parking:

1. General: Contractor must pay for all parking and, if available, may be assigned parking spaces in designated contractor parking lots. Parking in lots designated for visitors and patients is not permitted. Make arrangements for designated spaces and payment for long term parking with University Parking Services through the University Project Manager.

2. Provide temporary parking or use designated areas of University's existing parking areas as applicable to the Project and in accordance with the following:

    a. All parking on University property, including parking on University owned streets, is under the exclusive control and authority of University Parking and Transportation Services. Direct policy question to the department at (303) 724-2555.
    b. There is no free parking on campus. Displacement or use of existing parking spaces by Contractor, either for parking or for staging, is a Contractor cost.
    c. Use of existing parking spaces or other areas outside of Contractor's staging area must be approved in advance by University Parking and Transportation Services.
    d. University Parking and Transportation Services may require and issue parking permits through the University Project Manager. Permits must be displayed and visible at all times

while parked on the campus. Failure to display a permit will result in citations being written and possible removal of the vehicle from University property.

e. Keep all designated parking areas clean and free of litter and debris. University reserves the right to direct Contractor to clean areas not kept clean and orderly.

f. University Parking and Transportation Services may change parking assignments as deemed necessary, restrict the use of any space(s) or lot(s) at any time, and determine the hours of control and mode of operations for any parking area at any time. University Parking and Transportation Services may deny or revoke parking privileges to any person when deemed necessary and/or considered to be in the best interests of the University.

3. Parking on University property is at the Contractor's own risk. The University and any entity affiliated with it are not responsible for fire, theft, and damage to or loss of contractor's or subcontractor's vehicle or any article left therein. Only a license is granted to the user and no bailment is created.

E. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

1.9 COORDINATION WITH OCCUPANTS

A. University may occupy site and both existing and adjacent building(s) during entire construction period. Cooperate with University during construction and sequence operations to minimize conflicts and facilitate University usage. Perform the Work so as not to interfere with University's day-to-day operations.

1. Maintain existing exits from existing and adjacent building, unless otherwise indicated.
2. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from University and approval of authorities having jurisdiction.
3. Limit construction operations to those methods and procedures which will not adversely and unduly affect the working environment of University's occupied spaces, including noise, dust, odors, air pollution, ambient discomfort, poor lighting, hazards and other undesirable effects and conditions.
4. Coordinate with University Project Manager to schedule jack hammering or activities producing dusty conditions, excessive fumes or odors during off-hours.
5. When work must be accomplished in areas containing existing furniture, upon a minimum of 3 business days notification of the University Project Manager, University will remove or relocate existing furniture.
6. Provide not less than 72 hours' notice to University Project Manager of activities that will affect University's operations. University Project Manager will coordinate with campus tenants.

    a. Refer to "Work Restrictions" Article of this Section for procedures and notification requirements related to utility interruptions.

7. Provide temporary barriers and partitions, or other means as required to protect occupants of existing building and the general public from injury due to construction activities. Prevent the spread of dust and dirt to adjacent occupied areas and building.

1.10 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
2. In planning and executing the Work, take into consideration the special needs of University patient care, teaching and research settings, for example, supply of critical utilities, noise and dust control, access to existing loading docks, occupied buildings, etc.

B. Normal Working Hours: Limit work to working hours of 6:00 p.m. to 7:00 a.m., Monday through Friday and all day on weekends.

1. Notify University Project Manager of all proposed work outside of normal working hours. Include dates, times, names and contact information for contractors and subcontractor performing the Work with notification. University Project Manager will notify, as appropriate, other University personnel and departments including, but not limited to, Building Maintenance and Operations (BMO) Directors, BMO assigned representative, Campus Police and Facilities Management.

C. Noise and Vibration: Coordinate operations that may result in high levels of noise and vibration, or other disruption to University occupancy with University.

1. Noise during Normal Working Hours: Identify potentially disruptive construction activities at weekly Progress Meeting and adjust active time of day to reduce significant impacts on occupants.
2. Noise outside Normal Working Hours: Schedule construction work or demolition work outside of normal working hours with University Project Manager at minimum of 72 hours in advance.

    a. The maximum permissible noise level is 75 decibels (dBA), measured at the adjacent property line.

D. Contractor Identification:

1. Supervisory staff for the primary contractor must obtain an identification badge at the University Anschutz Medical Center (AMC) Building 500. Submit the University Access Control Badge Application form through University Project Manager. Submitted forms shall be complete with all required information including a letter on company letterhead confirming employee status with company and stating whether the company completes background testing and/or drug screening. Contractor supervision must display badge on site during construction activities.
2. To the greatest extent possible, Contractor's and subcontractor's employees must wear a recognizable logo shirt or hardhat identifying them as members of the contractor's work force.

E. Use of Existing Elevators: Use "freight" elevators only and protect finishes during transport. Restrict use exclusively to time required to move construction materials.

1. Do not block corridors, aisles, passageways or doors leading to elevator except as, and only to the extent approved by University Project Manager.

F. Keys: Submit written request to University Project Manager on University Key Request Form.

1. To the extent the need for keys is demonstrated and required to complete the Work, University Project Manager will issue keys to Contractor.
2. Contractor is responsible for all costs related to lost or non-returned keys.
3. Electrical, mechanical and sensitive research space may require University escort in lieu of issuing keys.

G. Dock Deliveries: Restrict use exclusively to time required to unload and move construction materials.

H. Existing Utility Interruptions: Do not interrupt water, sewer, plumbing, gas, steam, chilled water, oxygen, HVAC, electrical power, lighting, telephone and other related utilities serving facilities occupied

by University without prior notice to and approval by the University. Coordinate and schedule interruptions in advance through the University Project Manager in strict conformance with University Utility Interruption/Outage Request Procedure.

1. Form of Notice: University Utility Interruption and Start-up Request form.
2. Time of Notice: Notice for major and minor outages as defined by the Utility Interruption/Outage Request Procedure is 8 business days for minor outages and 31 business days for major outages.

I. Fire Alarm and Fire Sprinkler Interruptions: When construction activities require interruption of fire alarm or fire sprinkler service, or when dust from construction activities is likely to cause accidental alarm, advise University Project Manager who will submit an interruption request.

1. Form of Notice: University Fire Alarm/Sprinkler Disable Request Form.
2. Time of Notice: Prior to noon on the day before the anticipated interruption.

J. Nonsmoking Campus: Smoking, chewing tobacco, and other related tobacco product use is not permitted at any location on campus or on any adjacent property.

K. University Policies Applying to All Contractors: Comply with University policies applying to contractors including drug policy, sexual harassment policy and tobacco free policy. Obtain copies of University policies from University Project Manager.

1. Controlled Substances: Use of tobacco products and other controlled substances on Project site and surrounding Campus is not permitted.

L. Designated Eating Areas: Restrict consumption of food on project site to designated eating areas as approved by University Project Manager.

1.11 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
3. Words in the singular number include the plural and those in the plural include the singular.
4. Words of any gender include any other gender.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
3. Keynoting: Materials and products may be identified by reference keynotes referencing

Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 18 00

PROJECT UTILITY SOURCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes matrix of utility sources applicable to Project.

1.3 QUALITY ASSURANCE

A. Comply with utility company and regulatory agency codes, standards, and guidelines for the provision of new or extension of exiting utilities.

1.4 UTILITY SOURCE MATRIX

A. The following matrix summarizes utility responsible for provision of utility service:

	AMC				DC		AMC		DC	
	Trunk		**In Tract**		**Trunk**	**In Tract**	**Trunk**	**In Tract**	**Trunk**	**In Tract**
Steam	University	***Note 1***	Developer		Xcel	University	University	University	DW	University
Chilled Water	University	***Note 1***	Developer		NA	University	University	University	NA	University
Electricity	University	***Note 2***	Developer		Xcel	University	University	University	DW	University
Storm Drainage	COA		Developer		DW	University	University/ COA ***Note 5***	University	DW	University
Sanitary Sewer	COA		Developer		DW	University	University/ COA ***Note 5***	University	DW	University
Water	COA		Developer		DW	University	University/ COA ***Note 5***	University	DW	University
Telecommunications	University	***Note 3***	Developer	***Note 3***	University	University	University	University	DW	University
Natural Gas	Xcel	***Note 4***	Developer		Xcel	University	University	University	DW	University

University: University of Colorado Denver

COA: City of Aurora

DW: Denver Water

Developer:

University, TCH, UCH. In Tract lines are owned by the building they are feeding

Note 1: University owns Trunk steam and chilled water from CUP to vault

Note 2: University owns Trunk electrical from switch gear to manhole

Note 3: University owns Trunk telecom ductbank from main switch to manhole. Developer owns cable from switch to building

Note 4: Xcel has license agreement with University

Note 5: University and COA jointly permit

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 18 00

SECTION 01 21 00

ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.

1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

B. Types of allowances include the following:

1. Lump-sum allowances.

C. Related Requirements:

1. Section 01 22 00 "Unit Prices" for procedures for using unit prices.

1.3 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, advise Architect/Engineer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.

B. At Architect/Engineer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

C. Purchase products and systems selected by Architect/Engineer from the designated supplier.

1.4 ACTION SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.

1.5 INFORMATIONAL SUBMITTALS

A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.6 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.7 LUMP-SUM ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by University or selected by Architect/Engineer under allowance and shall include taxes, freight, and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by University and/or selected by Architect/Engineer under allowance shall be included as part of the Contract Sum and not part of the allowance.

C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to University, after installation has been completed and accepted.

1. If requested by Architect/Engineer, retain and prepare unused material for storage by University. Deliver unused material to University's storage space as directed.

1.8 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. Allowance No. 1: Lump-Sum Allowance: Include the sum of $3,500 for contractor borne costs for all on-site construction workers to go through CU required Q-Titer (Q-Fever testing), N95 Mask Test Fit and Costs of N95 masks and other PPE required for this project.

END OF SECTION 01 21 00

Perinatal Research Facility Disclosure

Occupational Health
ENVIRONMENTAL HEALTH AND SAFETY
UNIVERSITY OF COLORADO
DENVER | ANSCHUTZ MEDICAL CAMPUS

Access to the University of Colorado Anschutz Medical Campus Perinatal Research Facility (PRF) is restricted to essential personnel. The following information is for individuals that must enter the PRF to conduct short-term work activities who are not part of the PRF staff or faculty performing or supporting research activities. Sheep housed at the PRF may harbor Coxiella burnetii, a bacterium known to cause Q fever in humans.

Participation in respiratory protection and medical surveillance programs is mandatory to be able to work in the Perinatal Research Facility.

Anticipated Risk

The potential for human infection is greatest for individuals working directly with infected animals during the birthing process since amniotic fluids and the placenta contain high concentrations of the organisms. Direct handling of materials contaminated with amniotic fluids, placenta debris, terminated fetuses, or urine from infected sheep is also a high risk activity. Typically, the risk of infection due to casual exposure (such as walking through the facility or performing work on equipment within the complex) is low. If your work requires that you enter the restricted animal areas of the PRF, you may be at risk for contracting Q fever. If your previous work history involved handling of sheep before coming to this facility, you may already have been exposed and potentially unknowingly infected. Some people develop immunity to the organism after infection.

Respiratory Protection and Personal Protective Equipment

This pathogen is resistant to heat and drying and can become airborne. To ensure the safety of anyone entering areas within the PRF where research activities involving the handling of sheep are performed, individuals are required to wear respiratory protection (N95 respirator or other negative or positive pressure respirator fitted with HEPA filtration). Fit-testing for employees required to use a negative pressure respirator is a requirement of the Occupational Safety and Health Act (OSHA) regulations. The University of Colorado Denver | Anschutz Medical Campus provides fit testing and any required medical screening for employees of the institution and for non-University of Colorado Denver | Anschutz Medical Campus personnel that must enter the PRF to conduct short-term work activities

Entering the areas within the PRF where research activities involving the handling of sheep are performed also requires ABSL-2+ PPE personal protective equipment. This includes: solid-front lab coat with closed cuffs, double gloves, face shield, long pants/skirt/dress and eye protection, in addition to an N95 respirator.

Q Fever Medical Surveillance Program

All personnel entering the areas within the PRF where research activities involving the handling of sheep are performed are required to be enrolled in Q fever surveillance. This program is composed of the following:

1. Submission of an Initial Medical Surveillance Questionnaire (for initial enrollment) or Annual Medical Surveillance Questionnaire (annually after initial enrollment) indicating work in the PRF.
2. Appointment with Occupational Health for Q fever titer for enrollment in Q fever surveillance.
3. All individuals enrolled in the program will have a baseline serology test performed through Occupational Health prior to initiating work in the PRF. *A baseline sample must be obtained prior to entering the PRF.*
4. Complete Q fever Annual Screening Questionnaire prior to the annual blood draw (provided at appointment).
5. All individuals enrolled in the surveillance program will be screened annually for Q fever using phase I IgG and phase II IgG serology.
6. Serology and assessments will be performed on a yearly basis by the department. Enrollees into the surveillance program will be notified by email when they are due for their annual visit.
7. Enrollees who no longer enter the PRF will complete an exit titer with Occupational Health one month after their work concludes, then will be removed from the surveillance program.

Perinatal Research Facility Disclosure

Occupational Health
ENVIRONMENTAL HEALTH AND SAFETY
UNIVERSITY OF COLORADO
DENVER | ANSCHUTZ MEDICAL CAMPUS

Signs and Symptoms

Even if you become infected, you may not experience any symptoms. Only approximately fifty percent of people infected with *Coxiella burnetii* show signs of clinical illness. Symptoms of Q fever are similar to flu symptoms. An acute case of Q fever may begin with sudden onset of one or more of the following:

- high fever (up to 104-105° F)
- severe headache
- body discomfort and fatigue, or muscle pain
- confusion
- sore throat
- chills, sweats
- non-productive cough
- nausea, vomiting
- diarrhea, abdominal pain
- chest pain

Fever usually lasts for 1 to 2 weeks. Weight loss can occur and persist. In general, most people recover within several months without any treatment. However, some may develop complications. Thirty to fifty percent of people infected will develop pneumonia. A majority of those infected have abnormal results on liver function tests and some may develop hepatitis. One to two percent of individuals infected die of the disease. Individuals who are immuno-compromised are at a higher risk for serious illness. **If you believe you may have a compromised immune system, you should not enter the facility's animal areas.**

In rare cases, some individuals develop a chronic form of Q fever (infection that persists for more than 6 months), which may occur a year or more (as long as 20 years) after getting the disease. In these cases, inflammation of the heart, especially the valves in the heart, can be a serious problem. Most who develop chronic Q fever have pre-existing heart disease. Transplant recipients, patients with cancer, and those with chronic kidney disease are at risk of developing chronic Q fever. As many as sixty five percent of persons with chronic Q fever die of the disease.

If after entering the facility you experience the symptoms described (most become ill within 2-3 weeks after exposure), you should inform your medical care provider that you may have been exposed to *Coxiella burnetii* ("Q fever") and request appropriate laboratory testing to ensure an accurate diagnosis and proper treatment.

Please report any suspected infection to the University of Colorado Denver | Anschutz Medical Campus Environmental Health and Safety Department at 303-724-9145 and Occupational.Health@cuanschutz.edu.

Acknowledgement

If you must enter the restricted areas of the PRF, please print your name, sign and date below and send the signed form to occupational.health@cuanschutz.edu.

I _____(name), certify that I have read and understand the information provided to me by the University of Colorado Denver | Anschutz Medical Campus (herein) regarding the risk to me of exposure to Q fever pathogenic organisms that may exist in the PRF. I exercise my own free and voluntary choice to access the Perinatal Research Facility. I agree to assume all risk of personal injury or loss, and bodily injury (including death), arising out of my access to the Perinatal Research Facility. I also release, waive, indemnify, hold harmless, and discharge the University of Colorado from all claims, damages, and injuries arising out of my access to the Perinatal Research Facility, including contact with sheep and potential exposure to *Coxiella burnetii*.

_____ _____

Signature **Date**

Please indicate below your anticipated dates of entry to restricted areas and when you anticipate finishing your project in the Perinatal Research Facility:

_____

University of Colorado **Denver | Anschutz Medical Campus**

ENVIRONMENTAL HEALTH AND SAFETY | OCCUPATIONAL HEALTH

Date: _____ Invoice #: _____

Name (Last, First): _____ ID#: _____ DOB: _____

	Service Provided	Cost
	Medical Surveillance Charge	$75 (AMC) $100(DDC)
	CU Med New Hire	$100
	Vaccinia Consultation	$100
	Clinical Consultation	$75
	Respiratory Medical Evaluation	$60
	Drug Screen (Oral)	$300
Vaccines	Hep B (each, series of 2) Hep-li-sav	$130
	Hep B (each, series of 3) Engerix	$85
	Hep A/B (each, series of 3)	$120
	Hep A (each, series of 2)	$85
	MMR (each, series of 2)	$120
	Polio (each, series of 3)	$70
	Rabies (each, series of 3)	$350
	Td	$75
	Tdap	$75
	PPD	$30
	JEV (each, series of 2)	$325
	Varicella (each, series of 2)	$175
	Influenza (Flu)	$30
	Other:	
Titers	Hep B Antibody	$40
	Hep A Antibody	$40
	Q-Fever	$60
	TB Quantiferon	$60
	Varicella (chickenpox)	$50
	Rabies	$125
	MMR Combined	$70
	JEV Titer	$40
	WNV	$40
	Dengue	$40
	Lab Draw Fee	$25
	Other:	

Q Fever titers will be drawn twice per worker. Once will occur before work, one will occur one month after work concludes.

TOTAL		
Bill to Invoice		$
Speed type (ST)		$
Self-Pay	☐ Cash ☐ Check ☐ Credit Card	$
No Charge		$

EHSA Verified? ☐ _____ Completed by: _____

Dept: _____ PI/Sup: _____ ☐ Covered ☐ Not Covered

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 01 21 00 "Allowances" for products selected under an allowance, if applicable.
2. Section 01 23 00 "Alternates" for products selected under an alternate, if applicable.
3. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or University that are not required in order to meet other Project requirements but may offer advantage to Contractor or University.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit each request for consideration in format and quantities specified in Section 01 33 00 “Submittal Procedures”. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use CSI Form 13.1A or Contractor-generated form with substantially the same information.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.

b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by University and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect/Engineer's Action: If necessary, Architect/Engineer in consultation with the University will request additional information or documentation for evaluation within seven calendar days of receipt of a request for substitution. Architect/Engineer in consultation with the University will notify Contractor of acceptance or rejection of proposed substitution within 14 calendar days of receipt of request, or seven calendar days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order.
b. Use product specified if Architect/Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 14 calendar days prior to time required for preparation and review of related submittals.

1. Conditions: Architect/Engineer in consultation with the University will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
b. Requested substitution provides sustainable design characteristics that specified product provided.
c. Substitution request is fully documented and properly submitted.
d. Requested substitution will not adversely affect Contractor's construction schedule.
e. Requested substitution has received necessary approvals of authorities having jurisdiction.
f. Requested substitution is compatible with other portions of the Work.
g. Requested substitution has been coordinated with other portions of the Work.
h. Requested substitution provides specified warranty.
i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00

CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

2. Contractor's Agreement Design/Bid/Build, State Form SC-6.21 and The General Conditions of the Construction Contract Design/Bid/Build, State Form SC-6.23 for definitions and contractual requirements related to contract modification procedures.

1.3 DEFINITIONS

A. Change Order: A written order in compliance with the requirements of the Contract authorizing changes in the Work. For the purposes of this Section a Change Order and a Contract Amendment shall have the same meaning.

1.4 INFORMATIONAL SUBMITTALS

A. Contractor's Authorized Signatory: Submit name of individual authorized to accept changes and responsible for informing others employed by Contractor of changes in the Work.

1.5 MINOR CHANGES IN THE WORK

A. Architect/Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.6 CHANGE ORDER BULLETIN

A. University-Initiated Change Order Bulletin: Architect/Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications. It will also state the time period for which the request will remain valid.

1. Change Order Bulletin Form: State Form SC-6.311 available on the website of the Office of the State Architect.
2. Work Change Order Bulletins issued by Architect/Engineer are not instructions either to stop work in progress or to execute the proposed change.

B. Contractor-Initiated Change Order Bulletin: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect/Engineer.

1. Change Order Bulletin Form: State Form SC-6.311 available from the website of the Office of the State Architect.
2. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

1.7 CHANGE ORDER PROPOSAL

A. Change Order Proposal: In response to a University-Initiated Change Order Bulletin or accompanying a Contractor-Initiated Change Order Bulletin, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change described.

1. Change Order Proposal Form: State Form SC-6.312 available from the website of the Office of the State Architect.
2. Labor Rates: Prior to submitting first Change Order Proposal, submit bare, unburdened hourly labor rates for all contractor and subcontractor labor categories; submit itemized breakdown of all applicable additional labor benefit costs to be added to the bare labor cost to arrive at the total burdened hourly labor cost.
3. Equipment Costs: Provide cost backup for all equipment clearly indicating equipment billing rates and sufficient to demonstrate, as determined by the University Project Manager, that proposed rates are competitive and reasonable in all cases. Submit completed Change Order Proposal Form within the requested timeframe. Include backup documentation to support calculations consistent with Contract provisions, including but not limited to, the following:

a. Contractor and Subcontractor labor, material and equipment costs including:

1) A list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
2) Applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
3) Costs of labor and supervision directly attributable to the change and as permitted by the terms and conditions of the General Contract for Construction.

b. Contractor and Subcontractor overhead and profit.
c. Contractor’s bond cost.
d. Justification for Change in Contract Time: An updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity

duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

4. Maintain detailed records of work completed. Provide complete information for evaluation of proposed changes and to substantiate proposed changes in Contract Sum or Contract Time.

1.8 ADMINISTRATIVE CHANGE ORDERS

A. Allowance Adjustment: See Section 01 21 00 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.

B. Unit-Price Adjustment: See Section 01 22 00 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.9 CHANGE ORDER PROCEDURES

A. Submit three signed copies of Change Order Proposal to Architect/Engineer for review.

1. University-Initiated Change Order Bulletins: University and Architect/Engineer will evaluate Contractor's Change Order Proposal and either request additional information or suggest modifications. Based on this review and evaluation University will either accept or reject the proposal.
2. Contractor-Initiated Change Order Bulletins: Architect/Engineer will evaluate Contractor's claim based on the terms and conditions of the Contractor Agreement and General Conditions of the Construction Contract, as applicable.
3. Architect/Engineer's Action: When satisfied as to the accuracy and completeness of the Change Order Proposal, the Architect/Engineer will sign all three copies and forward to the University for consideration.

B. On University's approval of a Change Order Proposal, Architect/Engineer will prepare, sign and forward three copies of a Change Order, State Form SC-6.31 available from the website of the Office of the State Architect, for signature by the Contractor. Contractor then forwards all three copies of signed Change Order to the University for signature and distribution of fully executed copies to Architect/Engineer and Contractor for record.

C. Upon receipt of a fully executed Change Order, promptly perform the following:

1. Revise Schedule of Values on the Application for Payment Form by indicating each authorized Change Order as a separate line item and adjusting the Contract Sum as shown on the Change Order.

    a. University will not pay for changes to the Work until authorized by a Change Order signed by all parties.

2. Revise the Progress Schedule to reflect any change in the Contract Time.
3. Enter changes in the Project Record Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00

PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Section 01 21 00 "Allowances" for procedural requirements governing the handling and processing of allowances.
2. Section 01 22 00 "Unit Prices" for administrative requirements governing the use of unit prices.
3. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
4. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
5. For projects required to obtain LEED certification, Division 01 Section "Sustainable Design Requirements" for administrative requirements governing submittal of cost breakdown information required for LEED documentation.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor’s construction schedule. Schedule of values report from cost-loaded Critical Path Method Schedule prepared in accordance with Section 01 32 00 “Construction Progress Documentation” may serve to satisfy requirements for the schedule of values.

1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:

a. Application for Payment forms with continuation sheets.
b. Submittal schedule.
c. Items required to be indicated as separate activities in Contractor's construction schedule.

1) Construction Manager's Fee.

2) Estimated Project General Conditions Costs.

2. Submit schedule of values and hold a conference with the Architect/Engineer and University Project Manager to finalize the schedule of values at earliest possible date, but no later than 10 business days before the date scheduled for submittal of initial Certificates and Applications for Payment.

3. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:

a. Project name and location.
b. Name of Architect/Engineer.
c. Architect/Engineer's project number.
d. Contractor's name and address.
e. Date of submittal.

2. Arrange schedule of values consistent with format of AIA Document G703.
3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:

a. Related Specification Section or Division.
b. Description of the Work.
c. Name of subcontractor.
d. Name of manufacturer or fabricator.
e. Name of supplier.
f. Change Orders (numbers) that affect value.
g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

1) Labor.
2) Materials.
3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

a. Include separate line items under Contractor and principal subcontracts for LEED documentation, where applicable, and other Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.

6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

7. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not a direct cost of actual work-in-place shall be shown as separate line items in the schedule of values.

8. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect/Engineer and paid for by University.

1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Pay Application and Schedule Review Meetings: Conduct in accordance with Section 01 31 00 “Project Management and Coordination.” Provide draft application for payment and draft schedule update reflecting work accomplished during previous pay period. Review progress achieved; discuss and resolve issues affecting the progress; and review critical activities to be accomplished during the following 90 calendar days.

1. Jobsite Walk: When required, conduct a walk of the jobsite to confirm progress related to any activity in question.

C. Monthly Schedule Reporting: Upon conclusion of the Pay Application and Schedule Review Meeting, but not later than the 28th of the month, update the Construction Schedule and submit the Pay Application.

D. Payment Application Times: Submit Application for Payment to Architect/Engineer by the first day of the month and no more than five (5) business days prior thereto. The period covered by each Application for Payment is per the date indicated in the Application.

E. Payment Application Review: The Architect/Engineer shall, within five (5) business days after the receipt of each Certificate and Application for Payment, review the Project Application for Payment and either execute a Project Certificate for Payment to the University or notify the Contractor in writing of the reasons for withholding a Certificate.

1. All applications for payment, except the final application, and the payments there under, shall be subject to correction in the next application rendered following the discovery of any error

F. Application for Payment Forms: Use State Form SBP-7.2 “Certification for Contractor Payment.”

G. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect/Engineer will return incomplete applications without action.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders issued before last day of construction period covered by application.
4. Indicate separate amounts for work being carried out under University-requested project acceleration.

H. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site as approved in advance by the University Project Manager and items stored at an off-site location previously agreed upon in writing.

1. Provide certificate of insurance, evidence of transfer of title to University, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

I. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect/Engineer by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

J. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. For projects required to obtain LEED certification, LEED submittal for project materials cost data.
4. Contractor's construction schedule (preliminary if not final).
5. Products list (preliminary if not final).
6. For projects required to obtain LEED certification, LEED action plans.
7. Schedule of unit prices.
8. Submittal schedule (preliminary if not final).
9. List of Contractor's staff assignments.
10. List of Contractor's principal consultants.
11. Copies of building permits.
12. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
13. Initial progress report.
14. Report of preconstruction conference.

K. Application for Payment at Substantial Completion: After Architect/Engineer issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for University occupancy of designated portions of the Work.

L. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. All items on Pre-acceptance Checklist (State Form SBP-05) have been completed.
2. Notice of Acceptance (State Form SBP-6.27) has been issued.
3. Statements to support local sales tax refunds, if any submitted.
4. Notice of Contractor's settlement has been published.
5. Evidence of completion of Project closeout requirements, including but not limited to:

    a. Submittal of Record Documents.
    b. Submittal of all Operation and Maintenance Manuals.
    c. Completion of all required demonstration and training.

6. Updated final statement, accounting for final changes to the Contract Sum.
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when University took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. Requests for Information (RFIs).
4. Project Web site.
5. Project meetings.

B. Related Requirements:

1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

A. RFI: Request from Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Within 21 calendar days of Notice of Award submit, as complete as possible, a preliminary list to include all major subcontractors. Augment, complete and submit the final subcontractor list within 60 calendar days of Notice of Award, unless a longer duration is approved by the Architect/Engineer. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 14 calendar days after Notice to Proceed, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.5 GENERAL COORDINATION PROCEDURES

A. General: Each entity involved in the performance of work for the entire Project shall cooperate in the overall coordination of the Work; promptly, when requested, furnish information concerning its portion of the Work; and respond promptly and reasonably to the decisions and requests of persons designated with coordination, supervision, administrative or similar authority.

1. University Standard Project Management Forms

a. Where applicable, obtain from the University Project Manager and use the following University Standard Forms:

1) Preconstruction Agenda
2) Change Order Log with Contingency Codes
3) Access Control Badge Application Form
4) Utility Interruption Request Form
5) Utility Start-Up Request Form
6) Fire Alarm/Sprinkler Disable Request Form
7) Hot Work Permit Form
8) Anschutz Medical Campus (AMC) Street and Parking Lot Closure Form
9) Indoor Air Quality (IAQ) Planning Checklist
10) Indoor Air Quality (IAQ) Inspection Checklist

2. Site Utilization:

a. In addition to the site utilization limitations and requirements indicated in Section 01 10 00 “Summary” and indicated by the Contract Documents; administer the allocation of available space equitably among entities needing access and space, so as to produce the best overall efficiency in the performance of the total work of the project. Schedule deliveries so as to minimize the space and time requirements for storage of materials and equipment on the site; but do not unduly risk delays in the work.

b. Concurrent with work of the Contractor, other contractors, suppliers, and the University personnel may be working in relatively close proximity. The Contractor is solely responsible for coordinating their work with that of other contractors and will make no claims for failure to do so.

3. Layout:

a. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships of the various elements and systems and their interfacing with other elements and systems. Establishment and coordination of these relationships is the exclusive responsibility of the Contractor. Do not scale the drawings. Lay out and arrange all elements to contribute to safety, efficiency and to carry the harmony of design throughout

the Work. In case of conflict or undimensioned locations, verify required positioning with Architect/Engineer.

4. Substrate Examination:

   a. The Installer of each element of the work must examine the conditions of the substrate to receive the work, dimensions and spaces adjacent, tolerances, interfacing with other elements and services, and the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper or timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

5. Large and Heavy Equipment:

   a. Contractor to coordinate with University Project Manager requirements to be maintained for the subsequent entry of large equipment units. Coordinate the movement of heavy items with shoring and bracing, so that the building structure will not be overloaded during the movement and installation.
   b. Where equipment or products to be installed on the roof are too heavy to be hand-carried, do not transport across roof deck; position by crane or other device so as to avoid overloading the roof deck.

B. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections of the Specification that depend on each other for proper installation, connection, and operation.

1. Contractor Communication with the University: Direct all communication with the University through the University Project Manager.
2. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
3. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
4. Make adequate provisions to accommodate items scheduled for later installation.

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for University and separate contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

E. Coordination Of Submittals: Prior to transmittal to the Architect/Engineer, review shop and erection drawings, product data, and samples for compliance with Contract Documents and for coordination among work of all Sections of the Specifications. Coordination of submittals shall include, but not be limited to the following:

1. Verification of field dimensions and clearances and relationship to available space and anchors.
2. Verification of compatibility with equipment and work of other Sections, electrical characteristics, and operational control requirements.
3. Verification of motor voltages and control characteristics.
4. Coordination of controls, interlocks, wiring of pneumatic switches, and relays.
5. Coordination of wiring and control diagrams.
6. Review of the effect of any changes on work of other Sections.
7. For any item to be installed in or on a finished surface, certify that applicable Contract Documents have been checked and that the item submitted is compatible with the surface finish on which it is to be installed.
8. Equipment and material submittals shall show sufficient data to indicate complete compliance with Contract Documents as follows:

    a. Proper sizes and capabilities.
    b. Ability to fit in the available space in a manner that will allow proper service.
    c. Construction methods, materials, and finishes.
    d. List of accessories.

F. Special Coordination Requirements for Mechanical and Electrical Work:

1. General: Provide necessary work and services required to coordinate the complete installation of heating, ventilating, and air conditioning (HVAC) equipment and systems; plumbing systems and fixtures; electrical equipment, fixtures, and systems; and other equipment or systems containing motors and controls or requiring connection to mechanical or electrical systems; all so that the various systems perform as indicated and are in harmony with other project Work.
2. Contract Drawings:

    a. Drawings are schematic in nature, and indicate in general how the various components are integrated with other parts of the building. Coordinate exact locations by job measurement, by verifying the requirements of other trades, and by review of Contract Documents.

3. Mechanical and Electrical Drawings indicate general routing of the various parts of the systems, but do not indicate all sizes, fittings, offsets, and runouts which are required. Coordinate correct sizes, fittings, offsets, and runouts required to fit systems into allocated spaces. Coordinate locations of all light fixtures, vents, and supply grilles to conform to the ceiling grid system or other modular finishes.
4. Coordinate installation of mechanical and electrical work in compliance with the following requirements:

    a. Install piping, ductwork and similar services straight and true, aligned with other work, close to walls and overhead structure, allowing for insulation, concealed (except where indicated as exposed) in occupied spaces, and out-of-the-way with maximum passageway and headroom remaining in each space.
    b. Install electrical work in a neat, organized manner with conduit and similar services in or parallel with building lines, and concealed unless indicated as exposed.
    c. For all work maintain maximum practical overhead clearance but not less than 6" above ceiling. Where exposed, maintain 7'-0" minimum clearance.
    d. Arrange all work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference

with other work.

e. Provide space to permit removal of coils, tubes, fan shafts, filters, other parts which may require replacement.
f. Locate operating and control equipment and devices for easy access. Furnish access panels where units are concealed by finishes and similar work.
g. Integrate mechanical work in ceiling plenums with suspension system, light fixtures and other work, so that required performances of each will be achieved.
h. Give the right-of-way to piping systems required to slope for drainage over other service lines and ductwork.
i. Advise other trades of openings required in their work for accommodation of mechanical and electrical elements. Provide and place sleeves and anchors required in other work.

5. Access to Equipment: Except where located above accessible ceilings, provide access panels wherever access is required to concealed valves, controls, dampers, pull boxes and other devices requiring ongoing or periodic access.

a. Acceptable types of access panels are specified in Division 08.
b. Each trade is responsible for providing access panels needed for access to their equipment and coordinating installation with other Division 03, 04, 06 and 09 trades.
c. Coordinate requirements and obtain approval of locations from Architect/Engineer.

G. Compatibility of Systems:

1. Provide products and equipment which are compatible with other work requiring mechanical/electrical interface including electrical connections, control devices, water, drain and other piping connections. Verify electrical characteristics, fuel requirements and other interface requirements before ordering equipment and resolve conflicts that may arise.
2. Coordinate equipment, mechanical and electrical work in accordance with the following schedule:

ITEM	FURNISHED BY	MOUNTED BY	LOW VOLTAGE WIRED BY	POWER WIRED & CONNECTED BY	LOW VOLTAGE CONTROL CONNECTED BY
Equipment motors	I	MI	MI	EI	--
Motor starters, contactors and overload heaters	MI	EI	EI	EI	MI
Fused and unfused disconnect switches	EI**	EI**	EI**	EI	--
Manual operating switches, speed switches, push-button stations and pilot lights	MI	EI	EI	EI	EI
Duct detectors	EI	MI	MI	EI	MI
Control relays and transformers	MI	MI	MI	EI	MI
Thermostats, time switches*	MI	MI	MI	EI	MI
Temperature control panels	MI	MI	MI	EI	MI

Motor and solenoid valves, damper motors, PE and EP	MI	MI	MI	--	MI

switches					
Refrigeration equipment, cooling tower and controls	MI	MI	MI	EI	MI
Electric meters	EI	EI	EI	EI	MI
Steam meters	MI	MI	MI	MI	MI
Chilled water meters,	MI	MI	MI	MI	MI
Water meters	MI***	MI	MI	MI	MI
Natural Gas	MI	MI	MI	MI	MI

I = Installer of equipment requiring electrical service
EI = Electrical Installer
MI = Mechanical Installer

* Motor driven units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches or time switches which conduct full load current of the motor shall be wired for both power and control circuit under the electrical contract. However, if the control device does not conduct full load current, then the responsibility shall be that set forth in the above schedule. (Example: a 208 volt, 3-phase, 3- wire motor requires 120 volt control. Electrical Installer shall furnish a 120 volt circuit for control and 208 volt circuit for power and wire the power circuit. Mechanical Installer shall wire the control circuit.)

** Disconnects for AH units are factory mounted.

***Building Service meter provided by Civil. Any sub meter provided by MI. Coordinate meter requirements with utility for remote monitoring by 23 09 00 – Instrumentation and Controls.

H. Special Coordination Requirements for Exterior Envelope Work:

1. General: Provide necessary work and services required to coordinate the complete and continuous installation of the building's heat, air and moisture barriers. Exterior building envelope construction to be coordinated includes, but is not limited to, below-grade walls, slabs-on-grade, exterior opaque walls, windows, curtain walls, roofs, and skylights.

2. Contract Drawings:

   a. Drawings indicate general concepts and design intent for continuity of heat, air and moisture barriers at each exterior building envelope component and at transitions between building envelope components. Coordinate details for continuity based on actual product selections and Contractor's proposed sequence of construction.

I. Complete Systems:

1. It is the intent of the Contract Documents that all systems, including mechanical and electrical, be complete and functional to provide the intended or specified performance. Provide all incidental items and parts necessary to achieve this requirement.
2. Provide correctly sized power, utilities, piping, drains, services and their connections to equipment and systems requiring them, whether or not specific items are listed in the schedule under "Compatibility of Systems" paragraph in this Section.

J. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize

waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as University's property.

2. Establish recycling program at job site. Refer to Section 01 74 19 “Construction Waste Management and Disposal” for additional requirements.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

   a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
   b. Coordinate the addition of trade-specific information to the coordination drawings by multiple subcontractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
   c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
   d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
   e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
   f. Indicate required installation sequences.
   g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect/Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings, where required, to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab

depressions for floor finishes, curbs and housekeeping pads, and similar items.

6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
    d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Windows, Curtain Wall, and Exterior Wall Assembly Transition Work: Show all components of each adjacent wall or window system and all required compatible tie-ins between them including transition strips, flashings and sealants. Clearly identify each product, its configuration and its extent. Shop Drawings which only generically indicate adjacent construction and/or indicate “construction by others” will not be acceptable.
10. Review: Architect/Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect/Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect/Engineer will so inform Contractor, who shall make changes as directed and resubmit.
11. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00 "Submittal Procedures."

1.7 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect/Engineer will return RFIs submitted to Architect/Engineer by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect/Engineer.
6. RFI number, numbered sequentially.
7. RFI subject.

8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

14. Space for response and signature by Architect/Engineer.

C. RFI Forms: Hard copy form or software-generated form with substantially the same content as indicated above, acceptable to Architect/Engineer.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Architect/Engineer's Action: Architect/Engineer will review each RFI, determine action required, and respond. Allow seven calendar days for Architect/Engineer's response for each RFI. RFIs received by Architect/Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of Architect/Engineer's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect/Engineer's action may include a request for additional information, in which case Architect/Engineer's time for response will date from time of receipt of additional information.
3. Architect/Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Contractor-Initiated Change Order Bulletin and Proposal according to Section 01 26 00 "Contract Modification Procedures."

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect/Engineer in writing within seven calendar days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by RFI number. Submit log weekly. [**Use CSI Log Form 13.2B or Contractor-generated form of substantially same content.**] Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Architect/Engineer.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect/Engineer's response was received.

F. On receipt of Architect/Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect/Engineer within seven calendar days if Contractor disagrees with response.

1.8 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify University and Architect/Engineer of scheduled meeting dates and times a minimum of 4 business days prior to meeting.

a. Participants, including representatives of subcontractors and suppliers, shall be qualified, familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including University and Architect/Engineer, within three business days of the meeting.

B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time and site convenient to all parties, but not later than 14 calendar days after Notice to Proceed.

1. Conduct the conference to review responsibilities and personnel assignments.
2. Attendees: Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work and include the following:

a. Authorized representatives of University:

1) University Project Manager.
2) University Building Maintenance Operations (BMO) Representative.

b. Architect/Engineer and their consultants.
c. Contractor’s project manager and superintendent.
d. Major subcontractors and suppliers.
e. Other concerned parties shall attend the conference.

3. Agenda: Discuss items of significance that could affect progress, including the following:

a. Designation of key personnel and their duties.
b. Lines of communications.
c. List of major subcontractors and suppliers.
d. Tentative construction schedule.

1) Phasing.
2) Critical work sequencing and long-lead items.
3) Equipment deliveries and priorities.

e. Procedures and processing of:

1) Change Order Bulletin, Change Order Proposal and Change Orders.
2) RFI’s
3) Testing and inspecting.

4) Applications for Payment.
5) Submittals.
6) Preparation of record documents.

f. Use of the premises, existing building and adjacent buildings as applicable.

1) Work restrictions.
2) Working hours.
3) University's occupancy requirements.
4) Procedures for disruptions and shutdowns.
5) Construction parking and staging.
6) Construction route and site access.
7) Office, work, and storage areas.
8) Progress cleaning and housekeeping procedures.

g. Project coordination.
h. Distribution of the Contract Documents.
i. Temporary facilities and controls.
j. Indoor Air Quality Plan and Monitoring including procedures for moisture and mold control.
k. Construction waste management and recycling.
l. Safety.

1) Fire and Life Safety.
2) Health and Safety.

m. First aid.
n. Security.
o. Building Department.
p. Telecommunications.
q. Building Services.
r. Building Operations.
s. University Work Related Policies.
t. Contractor Contacts.
u. University Contacts.
v. University Process Forms.

1) Key Request Form.
2) Access Control Badge Application Form.
3) Utility Interruption Request Form.
4) Utility Start-Up Form.
5) Fire Alarm/ Sprinkler Disable Request Form.
6) Hot Work Permit Form.
7) Anschutz Medical Campus (AMC) Street and Parking Lot Closure Form.
8) Indoor Air Quality (IAQ) Plan.
9) IAQ Planning Checklist.
10) IAQ Inspection Checklist.
11) Request for Variance.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site for installations, systems or assemblies where required by individual Specification Sections, or where deemed necessary by Contractor.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect/Engineer of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following, as appropriate:

    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.
    f. Deliveries.
    g. Submittals.
    h. LEED requirements, for projects pursuing LEED certification.
    i. Review of mockups.
    j. Possible conflicts.
    k. Compatibility requirements.
    l. Time schedules.
    m. Weather limitations.
    n. Manufacturer's written instructions.
    o. Warranty requirements.
    p. Compatibility of materials.
    q. Acceptability of substrates.
    r. Temporary facilities and controls.
    s. Space and access limitations.
    t. Regulations of authorities having jurisdiction.
    u. Testing and inspecting requirements.
    v. Installation procedures.
    w. Coordination with other work.
    x. Required performance results.
    y. Protection of adjacent work.
    z. Protection of construction and personnel.

3. Record significant conference discussions, approved schedules, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information, including University Project Manager and Architect/Engineer.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to University and Architect/Engineer, but no later than **[30]** calendar days prior to the scheduled date of Substantial Completion or Partial Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work and include the following:

    a. University Project Manager.
    b. University Building Maintenance Operations (BMO) Representative.
    c. Architect/Engineer and their consultants.
    d. Contractor’s project manager and superintendent.

e. Major subcontractors and suppliers.
f. Other concerned parties.

3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Procedures related to:

1) Notice of Completion, including preparation of Contractor's punch list.
2) Final Inspection.
3) Notice of Substantial Completion.
4) Notice of Approval of Occupancy/Use.
5) Supplemental Occupancy/Use Checklist.
6) Supplemental Acceptance Checklist.
7) Pre-acceptance Checklists.
8) Notice of Acceptance.
9) Settlement and Final Payment.

b. Preparation of record documents.
c. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
d. Submittal of written warranties.
e. Requirements for completing LEED documentation, for projects pursuing LEED certification.
f. Requirements for preparing operations and maintenance data.
g. Requirements for delivery of material samples, attic stock, and spare parts.
h. Requirements for demonstration and training.
i. University's partial occupancy requirements.
j. Installation of University's furniture, fixtures, and equipment.
k. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at weekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work and include the following:

a. University Project Manager.
b. University Health Safety Department Representative.
c. University Building Maintenance Operations Representative.
d. University Campus Building Official.
e. Architect/Engineer and their consultants.
f. Contractor's project manager and superintendent.
g. Major subcontractors and suppliers.
h. Other entities concerned with current progress or involved in planning, coordination, or performance of future activities.
i. As needed, University Building Maintenance Operations (BMO), Subject Matter Experts (SME), and University Facility Support Services (FSS) Representatives.

3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule:

1) Review progress since the last meeting.
2) Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule.
3) Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
4) Review schedule for next two week period.
5) Review schedule of deliveries.
6) Review off-site fabrication.

b. Site Safety.
c. Indoor Air Quality Management monitoring.
d. MS4 Storm Water and Water Quality monitoring.
e. Quality:

1) Quality and work standards.
2) Status of correction of deficient items.
3) Progress cleaning.
4) Field observations.

f. Status of submittals.
g. Status of RFIs.
h. Status of Changes including:

1) Change Order Bulletins.
2) Change Order Proposals.
3) Change Orders.
4) Pending claims and disputes.

i. Status of LEED documentation, for projects pursuing LEED certification.
j. Review present and future needs of each entity present including:

1) Access.
2) Site utilization.
3) Temporary facilities and controls.
4) Coordination.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

F. Pay Application and Schedule Review Meeting: Conduct review meeting monthly on or about the 25th of each month.

1. Attendees:

a. University Project Manager.
b. Architect/Engineer.
c. Contractor’s Project Manager, Superintendant and Scheduler.

2. Agenda: Review draft pay application and progress schedule update in accordance with the requirements of Section 01 29 00 “Payment Procedures” and Section 01 32 00 “Construction Progress Documentation.”

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.
4. Daily construction reports.
5. Monthly project status reports.
6. Material location reports.
7. Site condition reports.
8. Special reports.

B. Related Requirements:

1. Section 01 33 00 "Submittal Procedures" for submitting schedules and reports.
2. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF electronic file and four paper copies.

B. Startup construction schedule (bar chart).

1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

1.5 QUALITY ASSURANCE

A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial University occupancy, as may be applicable.
4. Review delivery dates for University-furnished products.
5. Review schedule for work of University's separate contracts.
6. Review submittal requirements and procedures.
7. Review time required for review of submittals and resubmittals.
8. Review requirements for tests and inspections by independent testing and inspecting agencies.
9. Review time required for Project closeout and University startup procedures, including commissioning activities.
10. Review and finalize list of construction activities to be included in schedule.
11. Review procedures for updating schedule.

1.6 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date is not permitted. Contract completion date may only be modified by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 21 calendar days, unless specifically allowed by Architect/Engineer.
2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 calendar days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00

"Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.

4. Startup and Testing Time: Include adequate time for startup, testing and commissioning.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect/Engineer's administrative procedures necessary for issuing Notice of Substantial Completion.

C. Constraints: Include the following constraints and work restrictions as indicated in the Contract Documents and as applicable in schedule; show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work by University: Include a separate activity for each portion of the Work performed by University.
3. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
4. University-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
5. Work Restrictions: Show the effect of the following items, as applicable, on the schedule:

    a. Coordination with existing construction.
    b. Limitations of continued occupancies.
    c. Uninterruptible services.
    d. Partial occupancy before Substantial Completion.
    e. Use of premises restrictions.
    f. Environmental control.

6. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

    a. Submittals.
    b. Mockups.
    c. Fabrication.
    d. Sample testing.
    e. Deliveries.
    f. Installation.
    g. Tests and inspections.
    h. Building flush-out.
    i. Startup and placement into final use and operation.

7. Construction Areas: As applicable, identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

    a. Structural completion.
    b. Temporary enclosure and space conditioning.
    c. Permanent space enclosure.
    d. Completion of mechanical installation.
    e. Completion of electrical installation.
    f. Substantial Completion.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Commencement of Work, Substantial Completion, Notice of Occupancy and Use, and Final Acceptance. As applicable, also include milestones for Partial Substantial Completion and

Partial Notice of Occupancy and Use.

E. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

F. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules and as approved by University and Architect/Engineer.

2.2 STARTUP CONSTRUCTION SCHEDULE (BAR CHART)

A. Bar-Chart Schedule: Submit startup, horizontal, bar-chart-type construction schedule within seven calendar days of date established for commencement of the Work.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 calendar days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (BAR CHART OR GANTT CHART)

A. Bar-Chart or Gantt-Chart Schedule: Submit startup, horizontal, bar-chart-type or a comprehensive, fully developed, horizontal, Gantt-chart-type construction schedule within 30 calendar days of date established for commencement of the Work. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Use the same breakdown of construction activities as indicated in the Schedule of Values.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar. With each required construction schedule update, place a contrasting mark in each bar to indicate actual completion.

2.4 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.

11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Services connected and disconnected.
16. Equipment or system tests and startups.
17. Partial completions and occupancies.
18. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.5 SPECIAL REPORTS

A. General: Submit special reports directly to University within one calendar day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise University in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule draft update schedule for discussion and review at monthly project progress schedule and pay application review meeting.

1. Revise schedule immediately after each meeting and issue updated schedule concurrently with submittal of monthly Application for Payment.
2. Include summary reports with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.
4. Schedule updates may change logic but may not change milestone or critical path without prior approval of University and Architect/Engineer.

B. Distribution: Distribute copies of approved schedule to Architect/Engineer University, separate contractors,

testing and inspecting agencies, and other parties identified by Contractor with a need-to- know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 32 33 PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final completion construction photographs.

B. Related Requirements:

1. Section 01 33 00 "Submittal Procedures" for submitting photographic documentation.
2. Section 01 77 00 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For photographer.

B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

C. Digital Photographs: Submit image files within three business days of taking photographs.

1. Digital Camera: Minimum sensor resolution of 12 megapixels.
2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
3. Identification: Provide the following information with each image description in file metadata tag:

    a. Name of Project.
    b. Name and contact information for photographer.
    c. Name of Architect/Engineer.
    d. Name of Contractor.
    e. Date photograph was taken.
    f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    g. Unique sequential identifier keyed to accompanying key plan.

1.4 QUALITY ASSURANCE

A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.5 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to University for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Engage a qualified photographer to take construction photographs.

B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Date and Time: Include date and time in file name for each image.
2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect/Engineer.

D. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect/Engineer.

1. Flag construction limits before taking construction photographs.
2. Take [**20**] photographs of existing conditions in building to accurately record physical conditions at start of construction.

3. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

E. Periodic Construction Photographs: Take [**20**] photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

F. Architect/Engineer-Directed Construction Photographs: From time to time, Architect/Engineer will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.

G. Final Completion Construction Photographs: Take [**20**] color photographs after date of Substantial Completion for submission as project record documents. Architect/Engineer will inform photographer of desired vantage points.

1. Do not include date stamp.

H. Additional Photographs: University through Architect/Engineer may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.

1. Three business days' notice will be given, where feasible.
2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:

    a. Special events planned at Project site.
    b. Immediate follow-up when on-site events result in construction damage or losses.
    c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    d. Substantial Completion of a major phase or component of the Work.
    e. Extra record photographs at time of final acceptance.
    f. University's request for special publicity photographs.

END OF SECTION 01 32 33

SECTION 01 33 00 SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
5. Division 02 through 33 for additional submittal requirements specific to indicated Specification Sections.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect/Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals." Submittals not specifically indicated as informational submittals are considered to be action submittals.

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect/Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals" and include, but are not limited to:

1. Schedules.
2. Permits.
3. Applications for payment.
4. Performance and payment bonds.
5. Insurance certificates.

6. List of Subcontractors.
7. Schedule of Values.
8. Inspection and test results.
9. Closeout documents.
10. Coordination drawings.
11. Street and Storm Water Quality Management Plan.
12. Indoor Air Quality Management Plan.
13. Anschutz Medical Campus Street Services Request.

C. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect/Engineer and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.

2. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

3. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for resubmittal.
    g. Scheduled date for Architect/Engineer's final release or approval.
    h. Scheduled date of fabrication.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect/Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect/Engineer for Contractor's use in preparing submittals.

1. Architect/Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings [**and Project record drawings**].

    a. Architect/Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
    b. Digital Drawing Software Program: The Contract Drawings are available in <**AutoCad 2020**>.

c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to University and Architect/Engineer.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit for review with sufficient time to avoid construction delays.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

a. Architect/Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect/Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 14 calendar days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect/Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 14 calendar days for review of each resubmittal.
4. Large and/or Complex Submittals: For large and/or complex submittals, as determined by the Architect/Engineer and for submittals that require sequential reviews by Architect/Engineer’s consultants, a review period greater than 14 calendar days may be required. Architect/Engineer and Contractor shall identify such submittals upon submission of the submittal schedule and determine

D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately [**6 by 8 inches**] on label or beside title block to record Contractor's review and approval markings and action taken by Architect/Engineer.
3. Include the following information for processing and recording action taken:

a. Project name.
b. Date.
c. Name of Architect/Engineer.
d. Name and address of Contractor.
e. Name and address of subcontractor.
f. Name and address of supplier.
g. Name of manufacturer.
h. Submittal number or other unique identifier, including revision identifier.

1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

i. Number and title of appropriate Specification Section.
j. Drawing number and detail references, as appropriate.

k. Location(s) where product is to be installed, as appropriate.
l. Other necessary identification.

4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect/Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

   a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect/Engineer.

5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect/Engineer will return without review submittals received from sources other than Contractor.

   a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:

      1) Project name.
      2) Date.
      3) Destination (To:).
      4) Source (From:).
      5) Name and address of Architect/Engineer.
      6) Name and address of Contractor.
      7) Name of firm or entity that prepared submittal.
      8) Names of subcontractor, manufacturer, and supplier.
      9) Category and type of submittal.
      10) Submittal purpose and description.
      11) Specification Section number and title.
      12) Specification paragraph number or drawing designation and generic name for each of multiple items.
      13) Drawing number and detail references, as appropriate.
      14) Indication of full or partial submittal.
      15) Transmittal number.
      16) Submittal and transmittal distribution record.
      17) Remarks.
      18) Contractor's certification that information complies with Contract Document requirements.

6. Transmittal Form for Electronic Submittals: Use **electronic form** acceptable to University**,** containing the following information:

   a. Project name.
   b. Date.
   c. Name and address of Architect/Engineer.
   d. Name and address of Contractor.
   e. Name of firm or entity that prepared submittal.
   f. Names of subcontractor, manufacturer, and supplier.
   g. Category and type of submittal.
   h. Submittal purpose and description.
   i. Specification Section number and title.
   j. Specification paragraph number or drawing designation and generic name for each of multiple items.
   k. Drawing number and detail references, as appropriate.
   l. Location(s) where product is to be installed, as appropriate.
   m. Related physical samples submitted directly.
   n. Indication of full or partial submittal.

o. Transmittal number.
p. Submittal and transmittal distribution record.
q. Other necessary identification.
r. Contractor's certification that information complies with Contract Document requirements.
s. Remarks.

E. Options: Identify options requiring selection by Architect/Engineer.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect/Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

G. Contractor Certification: On transmittal include Contractor's certification that information complies with Contract Document requirements.

H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect/Engineer's action stamp.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect/Engineer's action stamp.

K. Record Documents: Retain complete additional copies of submittals on Project site to be submitted as record documents in accordance with requirements of Section 01 78 39 “Project Record Documents.”

L. Legibility: Provide clear and legible submittals. Submittals that are blurry or are for any reason unreadable will be returned without action.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Post electronic submittals as PDF electronic files directly to Project Management Software Web site specifically established for Project.

    a. Architect/Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Action Submittals: Submit three paper copies of each submittal to Architect/Engineer and one to University unless otherwise indicated. Architect/Engineer will return one copy.
3. Informational Submittals: Submit two paper copies of each submittal to Architect/Engineer and one to University unless otherwise indicated. Architect/Engineer will not return copies.

4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Manufacturer's installation instructions.
    d. Manufacturer's printed recommendations.
    e. Standard color charts.
    f. Statement of compliance with specified referenced standards.
    g. Statement of compliance with specified trade association standards.
    h. Testing by recognized testing agency.
    i. Application of testing agency labels and seals.
    j. Notation of coordination requirements.
    k. Notation of dimensions verified by field measurement.

4. For equipment, include the following in addition to the above, as applicable:

    a. Wiring diagrams showing factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.
    d. Rough-in diagrams and templates indicating clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Confirm compliance of Product Data with requirements of Contract Documents. Submit cover letter indicating Contractor’s certification of compliance.
7. Submit additional copies of Product Data as required complying with requirements of Section 01 78 39 “Project Record Documents.”

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Highlight, encircle or otherwise indicate deviations from Contract Documents. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect/Engineer's digital data drawing files is otherwise permitted. Standard information prepared without specific reference to the Project is not considered a shop drawing.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

    a. Identification of products.
    b. Schedules.
    c. Compliance with specified standards.
    d. Notation of coordination requirements.
    e. Notation of dimensions established by field measurement.
    f. Relationship and attachment to adjoining construction clearly indicated.
    g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than size of Construction Drawings.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Mount, display or package Samples in the manner specified to facilitate review of qualities indicated. Prepare Samples to match the Architect/Engineer's Sample.
3. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Sample source.
    d. Number and title of applicable Specification Section.
    e. Specification paragraph number and generic name of each item.
    f. Compliance with recognized standards.
    g. Availability and delivery time.

4. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect/Engineer will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Architect/Engineer will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.

        1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
        2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

7. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification

Sections. Such Samples must be in an undamaged condition at time of use.

b. Samples not incorporated into the Work, or otherwise designated as University's property, are the property of Contractor.

8. Distribution of Samples: Prepare and distribute additional sets to Subcontractors, manufacturers, fabricators, suppliers, Installers, and others as required for performance of the Work. Show distribution on transmittal forms.
9. Field Samples and Mock-Ups: Field Samples and mock-ups specified in individual Sections are full-size examples erected on site to illustrate finishes, coatings, or finish materials and to establish the standard by which the Work will be judged.

E. Selection of Related Materials: Where selections of colors, patterns, textures are specified to be made by Architect/Engineer, assemble complete samples of all specified or approved products for all Specification Sections and submit to Architect/Engineer. Review specifications and assemble all such samples for a combined single submittal. Indicate on the transmittal the latest date for selections to be made for each item to permit delivery of material in accordance with Progress Schedule. Architect/Engineer's action is limited solely to the specified selections or rejection of submittal items not in accordance with Specifications.

F. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."

G. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."

H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."

I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."

J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."

K. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."

L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

R. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

S. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect/Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect/Engineer. Submittals received without Contractor's substantive review and approval stamp will be rejected and returned to the Contractor.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT/ENGINEER'S ACTION

A. Action Submittals: Architect/Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect/Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

B. Informational Submittals: Architect/Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect/Engineer will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect/Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Architect/Engineer without action.

END OF SECTION 01 33 00

SECTION 01 35 44

SPECIAL PROCEDURES FOR ENVIRONMENTAL HEALTH AND SAFETY AND FIRE AND LIFE SAFETY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes special administrative and procedural requirements related to environmental health and safety.

B. University is Authority Having Jurisdiction (AHJ) for Fire and Life Safety. This responsibility is administered by the University's Fire and Life Safety Officer.

C. Related Requirements:

1. Section 01 35 46 "Indoor Air Quality Procedures" for procedure related to maintaining indoor air quality during construction.
2. Section 02 81 00 "Transportation/Disposal of Hazardous Materials."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 ENVIRONMENTAL HEALTH AND SAFETY AND FIRE AND LIFE SAFETY PROCEDURES

A. Physical, Life, and Fire Safety:

1. All contractors are required to conform to the Federal Occupational Safety and Health Administration (OSHA) regulations for construction (29 CFR 1926). Certain General Industry Standards (29 CFR 1910) may also apply, depending on location of work.
2. Provide an effective health and safety program to control hazards, including but not limited to compressed gases, welding, electrical, safety netting, cranes, scaffolding and supplies on the roof.
3. Provide fire protection in all construction areas to the satisfaction of the Authority Having Jurisdiction.
4. During the construction phase, the Authority Having Jurisdiction may conduct oversight inspections to observe and provide recommendations regarding applicable safety standards. The following minimum items are included:

    a. Do not block exit corridors. Install signage clearly identifying exit routes.
    b. Provide physical barriers with appropriate warning signage to protect public areas from

construction work.

c. Conduct daily inspections to eliminate fire hazards and any other safety hazards.
d. Periodic safety inspections will be performed on job sites by the Authority Having Jurisdiction. The Authority Having Jurisdiction for fire safety will present University's Project Manager with a written summary of the findings who will then take these issues to the Contractor's superintendent, foreman or other designated representative and return the summary form with documentation of the resolution of safety items to AHJ. Abate deficient items in a timely manner. Include documentation and resolution of safety items presented in weekly Progress Meeting minutes. Inspections by University AHJ are spot- checks only. They are not all encompassing. These inspections and recommendations do not relieve the Contractor from obligations related to safe work practices, as required under federal law.
e. AHJ has the right to access the site at all times. Should a potential threat to personnel or property be observed, AHJ may require the hazard related operation immediately altered until adequate safeguards are addressed.
f. Supply AHJ, through the University Project Manager, with a copy of Contractor's weekly safety meeting minutes and safety inspection reports.
g. Provide signs used for proper identification of construction areas.
h. Provide adequate number of appropriately rated fire extinguishers to be available on-site for emergency use in the construction area.
i. Insure standpipes, pull stations, electrical panels, water control valves and fire hydrants are accessible at all times.
j. Post emergency notification phone numbers provided by Contractor and University in all construction areas.
k. Notify University Project Manager of any lost time injuries occurring on University's property within one (1) calendar day and of any fatalities immediately.
l. Submit copies of all injury reports to AHJ, through University's Project Manager.
m. Equip construction personnel with personal protective equipment (PPE) where required. Coordinate with University Project Manager to identify where use of PPE will be required.

B. OSHA Hazard Communication Standard:

1. Every Contractor and Subcontractor performing work shall to comply with the OSHA Hazard Communication Standard. Compliance includes joint University and Contractor responsibilities for the purpose of providing timely communications and information sharing with regard to hazardous materials, chemicals and chemical sources which may be present on-site or brought in by Contractor.
2. University Project Manager will provide Contractor with the following:

    a. Information regarding known hazardous chemicals and agents or other hazards present at the job site.
    b. University emergency procedures and contact numbers.

3. Provide safety training and environmental surveillance of all workers.
4. Inform and provide University's Project Manager the following:

    a. Material safety data sheets (MSDS) for all chemicals introduced into the workplace.
    b. Information regarding potential sources of pollutants which may be entrained in University's air intakes, e.g., roofing tar fumes, nuisance dusts, exhaust from internal combustion engines, welding or cutting fumes, and asbestos - if damaged or encountered during the course of the work.

C. Asbestos and Lead Paint:

1. The presence of asbestos-containing materials and/or paint containing lead on the job site does not mean a problem exists. Areas where asbestos is friable and not contained or lead paint is present or

will be caused to be present in airborne or settled dust are of concern.

2. Responsibilities of University and Contractor regarding asbestos and lead paint are as follows:

   a. University:

      1) Notify the Contractor of the condition and location(s) where asbestos is known to be present or may reasonably be encountered, e.g., asbestos insulation, ceiling tiles, floor tiles, fire doors, wall and ceiling plasters, concrete, grouting, etc., and lead paint on metal building materials, walls, windows, etc.
      2) Coordinate with Contractor when response action is required by a Subcontractor.
      3) Contract with third party contractor to monitor areas where friable asbestos and/or lead-containing particles are present during construction/renovation projects for its own records and purpose. Monitoring results can be shared with Contractors but are in no way to be used for Contractor employee monitoring.
      4) Final authority on all asbestos-related concerns and contractual arrangements.

   b. Contractor:

      1) Notify University's Project Manager of any suspected or existing problem involving asbestos or lead and cease work in that area until University has assessed the situation.
      2) Ensure that undamaged asbestos-containing material and/or material containing lead, not included in the scope of the project, are not damaged.
      3) Train and monitor their own employees, including Asbestos Awareness training and Lead Paint Awareness training, where applicable.
      4) Be responsible for all environmental/industrial hygiene surveillance of its work staff and subcontractors and for required area monitoring where potential contamination of adjacent areas exists.
      5) Prevent problems which can result in asbestos or lead exposure to building occupants.
      6) Coordinate with the University’s EHS Department and Building Maintenance and Operations through University’s Project Manager and perform all activities that may potentially disturb asbestos containing materials in a manner acceptable to the EHS.
      7) Follow State of Colorado regulation, Emission Standards for Asbestos, Part B, Control of Asbestos, “Regulation 8” and OSHA standards regulating exposure to asbestos and lead.
      8) Where applicable, comply with Section 02 81 00 “Transportation/Disposal of Hazardous Materials.”
      9) Comply with current “Asbestos-Contaminated Soil Management Standard Operating Procedure Document, University of Colorado Anschutz Medical Campus” during excavation operations.

D. Carcinogens:

   1. Contractor or any Subcontractor shall not knowingly install or cause to be installed any material or product containing carcinogens. Refer to Annual Report on Carcinogens, U.S. Department of Health and Human Services, National toxicology Program.

E. Hazardous Waste:

   1. All hazardous wastes are to be handled and disposed of according to current EPA and CDPHE guidelines which can be obtained through University Project Manager. Only individuals specifically authorized by University may sign hazardous waste manifests for wastes generated on University’s property. Only University approved transporters and disposal facilities are to be used for transportation and disposal of hazardous wastes.

F. The Control of Hazardous Energy (Lockout/Tagout):

1. Provide and enforce a program and procedures for the control of hazardous energy (lockout/tagout) including, but not limited to, locks, tags and lockout devices. Provide proof that workers have received safety training in the control of hazardous energy through lockout/tagout.

G. Hot Work Operations:

1. Comply with University hot work policy and obtain Hot Work Permit prior to executing any hot work in existing buildings.
2. Notify University Project Manager prior to any hot work on University property.
3. Provide and enforce a program to control fires during hot work operations. Provide appropriately rated fire extinguishers, fire retardant protective covers (when needed), and any other hot work related equipment.

H. Confined Space Entry:

1. Work in compliance with the "Confined Spaced Entry Procedure for Non-University Personnel" whenever any project requires entry into a confined space. A copy of this procedure can be obtained from University EHS through University's Project Manager.

I. Green Tagging of Work Area:

1. Obtain a Green Tag and Construction Permit from the University Project Manager prior to any work being conducted in a laboratory or on any exhaust ductwork system serving a laboratory. If a Green Tag has been issued, it will be displayed at the entry of the laboratory area. The Green Tag assures that any radioactive, chemical or biological materials have been removed from the laboratory verifying the area is free from hazards to workers. If a Green Tag is not displayed, coordinate tagging with EHS through University's Project Manager.

END OF SECTION 01 35 44

Indoor Air Quality Plan

Project **23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades**

Completed by: _____
(Name & Company)

Date: _____

This plan describes the measures to be taken to provide good indoor air quality (IAQ) during construction and after construction is complete and the occupants have moved into the building. This plan is based on the SMACNA standard "IAQ Guidelines for Occupied Buildings under Construction" and the requirements of the LEED.

It is not the intent of this document to replace or supersede OSHA regulations as to safe construction workplace practices. It remains the responsibility of the Construction Manager and the individual sub-contractors to maintain safe building and site operations. Addition precautions may be necessary when hazardous materials are present.

The plan will address construction IAQ by recommending procedures in five areas of concern, which in turn will allow the building to achieve two LEED program points:

- HVAC system protection
- Containment source control
- Pathway interruption
- Housekeeping
- Scheduling

The following describes the specific measures to be performed in each area of concern:

1. HVAC Protection

    - During construction, provide MERV 13 filters for supply air intake when in use. Provide MERV 8 filters at the return air system openings when in use. Perform frequent maintenance when the HVAC system is being utilized and replace filters as they become loaded, prior to building flushout, and prior to occupancy.
    - When performing construction activities that produce dust, such as drywall sanding, concrete cutting, masonry work, wood sawing or adding insulation, seal off the supply diffusers and return air system openings completely for the duration of the task.
    - Shut down and seal off the supply diffusers and return air ducts during any demolition operations.
    - Whenever the HVAC system is not used during construction, seal off the supply diffusers and return air system openings to prevent the accumulation of dust and debris in the duct system.
    - Do not use the mechanical rooms to store construction or waste materials. Keep rooms clean and neat.
    - Provide periodic duct inspections during construction; if the ducts become contaminated due to inadequate protection, clean the ducts professionally in accordance with NADCA (National Air Duct Cleaning Association) standards.
    - The General Contractor shall take photographs showing measures in place.

2. Source Control

    - Use low VOC products as indicated by the specifications to reduce potential problems.

- Restrict traffic volume and prohibit idling of motor vehicles where emissions could be drawn into the building.
- Utilize electric or natural gas alternatives for gasoline and diesel equipment where possible and practical. Use low-sulfur diesel in lieu of regular diesel.
- Cycle equipment off when not being used or needed.
- Exhaust pollution sources to the outside with portable fan systems. Prevent exhaust from recirculating back into the building from construction equipment outside the building.
- Keep containers of wet products closed as much as possible. Cover or seal containers of waste materials that can release odor or dust.
- Protect stored on-site or installed absorptive building materials from weather and moisture; wrap with plastic and seal tight to prevent moisture absorption.
- The General Contractor shall take photographs showing measures in place.

3. Pathway Interruption

- Provide dust curtains or temporary enclosures to prevent dust from migrating to other areas when applicable.
- Locate pollutant sources as far away as possible from supply ducts and areas occupied by workers when feasible. Supply and exhaust systems may have to be shut down or isolated during such activity.
- During construction, isolate areas of work to prevent contamination of clean or occupied areas. Pressure differentials may be utilized to prevent contaminated air from entering clean areas.
- Depending on weather, ventilation using 100% outside air will be used to exhaust contaminated air directly to the outside during installation of VOC emitting materials.

4. Housekeeping

- Provide regular cleaning concentrating on HVAC equipment and building spaces to remove contaminants from the building prior to occupancy.
- All coils, air filters, fans and ductwork shall remain clean during installation and, if required, will be cleaned prior to performing the testing, adjusting and balancing of the systems.
- Suppress and minimize dust with wetting agents or sweeping compounds. Utilize efficient and effective dust collecting methods such as a damp cloth, wet mop, or vacuum with particulate filters, or wet scrubber.
- Remove accumulations of water inside the building. Protect porous materials such as insulation and ceiling tile from exposure to moisture.
- Thoroughly clean all interior surfaces prior to replacing filters and running HVAC system for system balancing, commissioning and building flushout.
- Provide photographs of the above activities during construction to document compliance.

5. Scheduling and Construction Activity Sequence

- Schedule high pollution activities that utilize high VOC level products (including paints, sealers, insulation, adhesives, caulking and cleaners) to take place prior to installing highly absorbent materials (such as ceiling tiles, gypsum wall board, fabric furnishing, carpet and insulation, for example). These materials will act as ‘sinks’ for VOCs, odors and other contaminants, and release them later after occupancy.

PLANNING AND INSPECTION CHECKLISTS

The planning and inspection checklists included in this document are useful to ensure construction IAQ management is planned and implemented correctly. The planning checklist should be completed by the contractor prior to construction. The inspection checklists should be completed monthly to confirm the IAQ management plan is being followed. At the

time of inspection, photographs should be taken to support the checklist and to provide audit documentation for the USGBC.

University of Colorado Denver IAQ
February 14, 2009

Planning Checklist
(Must be completed weekly**)**

Project **23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades**

Completed by: _____
(Name & Company)

Date: _____

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1. HVAC Protection

- ☐ MERV 13 filters at supply air intake
- ☐ MERV 8 filters at return air openings
- ☐ Seal supply diffusers and return air during demolition
- ☐ Seal supply diffusers and return air openings during construction
- ☐ Mechanical rooms clean and neat
- ☐ Periodic duct inspections during construction
- ☐ General Contractor to document with photographs

2. Source Control

- ☐ Low/no VOC products as indicated by specifications
- ☐ Restrict vehicle traffic volume and prohibit idling
- ☐ Utilize electric or natural gas alternatives for gasoline and diesel
- ☐ Cycle equipment off when not being used or needed
- ☐ Exhaust pollution sources to the outside
- ☐ Keep containers of wet products closed
- ☐ Cover or seal containers of waste materials
- ☐ Protect absorptive building materials from weather and moisture
- ☐ Prevent fume migration from construction vehicles and equipment into adjacent buildings
- ☐ General Contractor to document with photographs

3. Pathway Interruption

- ☐ Provide dust curtains or temporary enclosures
- ☐ Locate pollutant sources as far away as possible from supply dusts and areas occupied by workers
- ☐ General Contractor to document with photographs
- ☐ Isolate areas of work to prevent contamination of clean or occupied areas
- ☐ When using VOC emitting materials ventilate using 100% outside air

- ☐ General Contractor to document with photographs

4. Housekeeping

- ☐ Provide regular cleaning, including HVAC equipment
- ☐ If necessary clean HVAC equipment prior to testing, adjusting and balancing the systems
- ☐ Suppress and minimize dust with wetting agents or sweeping compounds
- ☐ Remove accumulations of water inside the building
- ☐ Protect porous materials
- ☐ General Contractor to document with photographs

5. Scheduling and Construction Activity Sequence

- ☐ Schedule high pollution activities prior to installing absorbent materials
- ☐ General Contractor to document with photographs

I confirm the checked activities to be proceeding according to the Construction Indoor Air Quality Plan. Items that are not checked will be addressed, initialed and dated once corrective actions have been taken. Items that are not applicable are labeled as such.

igned:_____ Date: _____
(Contractor)

University of Colorado Denver IAQ
February 14, 2009

Inspection Checklist
(Must be completed weekly**)**

Project **23-110899 Perinatal Research Facility Power HVAC Boiler Upgrades**

Completed by: _____
(Name & Company)

Date: _____

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1. HVAC Protection

- ☐ MERV 13 filters at supply air intake
- ☐ MERV 8 filters at return air openings
- ☐ Seal supply diffusers and return air during demolition
- ☐ Seal supply diffusers and return air openings during construction
- ☐ Mechanical rooms clean and neat
- ☐ Periodic duct inspections during construction
- ☐ General Contractor to document with photographs

2. Source Control

- ☐ Low/no VOC products as indicated by specifications
- ☐ Restrict vehicle traffic volume and prohibit idling
- ☐ Utilize electric or natural gas alternatives for gasoline and diesel
- ☐ Cycle equipment off when not being used or needed
- ☐ Exhaust pollution sources to the outside
- ☐ Keep containers of wet products closed
- ☐ Cover or seal containers of waste materials
- ☐ Protect absorptive building materials from weather and moisture
- ☐ General Contractor to document with photographs

3. Pathway Interruption

- ☐ Provide dust curtains or temporary enclosures
- ☐ Locate pollutant sources as far away as possible from supply dusts and areas occupied by workers
- ☐ General Contractor to document with photographs
- ☐ Isolate areas of work to prevent contamination of clean or occupied areas
- ☐ When using VOC emitting materials ventilate using 100% outside air
- ☐ General Contractor to document with photographs

4. Housekeeping

- ☐ Provide regular cleaning, including HVAC equipment
- ☐ If necessary clean HVAC equipment prior to testing, adjusting and balancing the systems
- ☐ Suppress and minimize dust with wetting agents or sweeping compounds
- ☐ Remove accumulations of water inside the building
- ☐ Protect porous materials
- ☐ General Contractor to document with photographs

5. Scheduling and Construction Activity Sequence

- ☐ Schedule high pollution activities prior to installing absorbent materials
- ☐ General Contractor to document with photographs

I confirm the checked activities to be proceeding according to the Construction Indoor Air Quality Plan. Items that are not checked will be addressed, initialed and dated once corrective actions have been taken. Items that are not applicable are labeled as such.

Signed:_____ (Contractor)

Date: _____

SECTION 01 35 46

INDOOR AIR QUALITY PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for managing emissions and moisture control during construction.

1.3 DEFINITIONS

A. Sustainable Design Related Terminology: As defined is ASTM E 2114.

B. Adequate Ventilation: Ventilation, including air circulation and air changes, required to cure materials, dissipate humidity, and prevent accumulation of particulates, dust, fumes, vapors, or gases.

C. Hazardous Materials: Any material that is regulated as a hazardous material in accordance with 49 CFR 173, requires a Material Safety Data Sheet (MSDS) in accordance with 29 CFR 1910.1200, or which during end use, treatment, handling, storage, transportation or disposal meets or has components which meet or have the potential to meet the definition of a Hazardous Waste in accordance with 40 CFR 261. Throughout this specification, hazardous material includes hazardous chemicals.

1. Hazardous materials include: pesticides, biocides, and carcinogens as listed by recognized authorities, such as the Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC).

D. Indoor Air Quality (IAQ): The composition and characteristics of the air in an enclosed space that affect the occupants of that space. The indoor air quality of a space refers to the relative quality of air in a building with respect to contaminants and hazards and is determined by the level of indoor air pollution and other characteristics of the air, including those that impact thermal comfort such as air temperature, relative humidity and air speed.

E. Interior Final Finishes: Materials and products that will be exposed at interior, occupied spaces including but not limited to flooring, wallcovering, finish carpentry, and ceilings.

F. Packaged Dry Products: Materials and products that are installed in dry form and are delivered to the site in manufacturer's packaging including but not limited to carpets, resilient flooring, ceiling tiles, and insulation.

G. Wet Products: Materials and products installed in wet form, including paints, sealants, adhesives, special coatings, and other materials which require curing.

1.4 QUALITY ASSURANCE

A. Inspection and Testing Lab Qualifications: Minimum of 5 years experience in performing the types of testing specified herein.

1.5 PRECONSTRUCTION MEETING

A. After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with University and Architect/Engineer to review and discuss the proposed IAQ Management Plan and develop a mutual understanding of detailed requirements for maintaining indoor air quality and environmental protection.

1.6 SUBMITTALS

A. Indoor Air Quality (IAQ) Management Plan: Not less than 10 business days before the Pre-construction meeting, prepare and submit an IAQ Management Plan including, but not limited to, the following:

1. Procedures for control of emissions during construction.

    a. Identify schedule for application of interior finishes.

2. Procedures for moisture control during construction.

    a. Identify porous materials and absorptive materials.
    b. Identify schedule for inspection of stored and installed absorptive materials.

3. Revise and resubmit Plan as required by University.

    a. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations.

B. Product Data:

1. Submit product data for filtration media used during construction and during operation. Include Minimum Efficiency Reporting Value (MERV).
2. Submit air pressure difference maps for each mode of operation of HVAC.
3. Material Safety Data Sheets: Submit MSDSs for inclusion in Operation and Maintenance Manual for the following products. Coordinate with Section 01 78 23 – Operation and Maintenance Data.

    a. Adhesives.
    b. Floor and wall patching/leveling materials.
    c. Caulking and sealants.
    d. Insulating materials.
    e. Fireproofing and firestopping.
    f. Carpet.
    g. Paint.
    h. Clear finish for wood surfaces.
    i. Lubricants.
    j. Cleaning products.

C. Inspection and Test Reports:

1. Moisture control inspections.

2. Moisture content testing.
3. Moisture penetration testing.
4. Microbial growth testing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 IAQ MANAGEMENT - EMISSIONS CONTROL

A. Provide point person responsible for the implementation and assurance that the Indoor Air Quality Plan is being implemented.

B. University Indoor Air Quality Plan: Comply with the requirements of the University IAQ Plan, latest version, appended to this Specification Section.

C. Flush-Out: After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu.ft. of outdoor air per sq.ft. of floor area while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%.

3.2 IAQ MANAGEMENT - MOISTURE CONTROL

A. Housekeeping:

1. Keep materials dry. Protect stored on-site and installed absorptive materials from moisture damage.
2. Verify that installed materials and products are dry prior to sealing and weatherproofing the building envelope.
3. Install interior absorptive materials only after building envelope is sealed and weatherproofed.

B. Inspections: Document and report results of inspections; state whether or not inspections indicate satisfactory conditions.

1. Examine materials for dampness as they arrive. If acceptable to University, dry damp materials completely prior to installation; otherwise, reject materials that arrive damp.
2. Examine materials for mold as they arrive and reject materials that arrive contaminated with mold.
3. Inspect stored and installed absorptive materials regularly for dampness and mold growth. Inspect weekly.

    a. Where stored on-site or installed absorptive materials become wet, notify Architect/Engineer and University. Inspect for damage. If acceptable to University, dry completely prior to closing in assemblies; otherwise, remove and replace with new materials.

4. Basement: Monitor basement and crawlspace humidity, and dehumidify when relative humidity is greater than 85 percent for more than 2 weeks or at the first sign of mold growth.
5. Site drainage: Verify that final grades of site work and landscaping drain surface water and ground water away from the building.
6. Weather-proofing: Inspect moisture control materials as they are being installed. Include the following:

a. Air and weather-resistive barrier: Verify air and weather-resistive barrier is installed without punctures and/or other damage. Verify air barrier and weather-resistive is sealed completely.
b. Flashing: Verify correct shingling of the flashing for roof, walls, windows, doors, and other penetrations.
c. Insulation layer: Verify insulation is installed without voids.
d. Roofing: In accordance with ASTM D7186 Standard Practice for Quality Assurance Observation of Roof Construction and Repair

7. Plumbing: Verify satisfactory pressure test of pipes and drains is performed before closing in and insulating lines.
8. HVAC: Inspect HVAC system as specified in Section 23 08 00 – Commissioning.

a. And, inspect HVAC to verify:

1) Condensate pans are sloped and plumbed correctly.
2) Access panels are installed to allow for inspection and cleaning of coils and ductwork downstream of coils.
3) Ductwork and return plenums are air sealed.
4) Duct insulation is installed and sealed.
5) Chilled water line and refrigerant line insulation are installed and sealed**.**

C. Schedule:

1. Schedule work such that absorptive materials, including but not limited to porous insulations, paper-faced gypsum board, ceiling tile, and finish flooring, are not installed until they can be protected from rain and construction-related water.
2. Weather-proof as quickly as possible. Schedule installation of moisture-control materials, including but not limited to air and weather-resistive barriers, flashing, exterior sealants and roofing, at the earliest possible time.

D. Testing for Moisture Content: Test moisture content of porous materials and absorptive materials to ensure that they are dry before sealing them into an assembly. Document and report results of testing. Where tests are not satisfactory, dry materials and retest. If satisfactory results cannot be obtained with retest, remove and replace with new materials.

1. Concrete: Moisture test prior to finish flooring application as specified in Division 09.

2. Wood: Moisture test as per ASTM D4444 - Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters; unless otherwise indicated acceptable upper limits for wood products are < 20% at center of piece; < 15% at surface.

3. Gypsum Board, Gypsum Plaster, Insulation, and other absorptive materials: Moisture test with a Pinless Moisture Meter to assess patterns of moisture, if any.

E. Testing for Moisture Penetration:

1. Windows: Test as per ASTM E1105 Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference at 100 percent static-air-pressure difference specified in applicable Division 08 Sections; unless otherwise indicated, acceptable upper limits are no leakage for 15 minutes**.**

a. Number of Tests: 1 percent of openings but not less than two.

2. Horizontal Waterproofing (not roofing): Test as per ASTM D5957 Standard Guide for Flood Testing Horizontal Waterproofing Installations; acceptable upper limits are no leakage for 15 minutes**.**

a. Test frequency: 100 percent of horizontal waterproofed surfaces.

3. Masonry: Test as per ASTM C1601 Standard Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces; acceptable upper limits are no leakage for 15 minutes.

4. Exterior Walls:

a. Air tightness of the enclosure test: ASTM E779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization or ASTM E1827

1) Air Leakage: The mean value of the air leakage flow rate calculated from measured data at 0.3 in wg (75 Pa) must not exceed 0.25 cu ft/ minute per square foot of envelope area. Measurements must be referenced at standard conditions of 14.696 psi (101.325 KPa) and 68 deg F.

F. Testing for Support of Microbial Growth: Test and report in accordance with ASTM D6329 Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers. Indicate susceptibility of product or material to colonization and amplification of microorganisms. Identify microorganisms and conditions of testing.

1. Normal conditions: Perform testing at 35 degrees Centigrade and 50 percent relative humidity.
2. Extreme conditions: Perform worst case scenarios screening tests by providing an atmosphere where environmental conditions may be favorable for microbial growth.
3. Perform testing for the following:

a. Fireproofing material on appropriate substrate.
b. Ceiling tile.
c. Wall covering.
d. Other appropriate material.

END OF SECTION 01 35 46

SECTION 01 40 00 QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect/Engineer, University, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

C. Related Requirements:

1. Section 01 42 00 "Reference" for list of references, standards and definitions.
2. Section 01 91 13 “General Commissioning” for coordination of testing with commissioning activities.
3. Division 23 for testing, adjusting and balancing of mechanical systems.
4. Division 26 for testing of electrical systems.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect/Engineer.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities

of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. As indicated in individual Specifications Sections or on the Drawings, the Work may include the following types of mockups:

    a. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
    b. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
    c. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect/Engineer for a decision before proceeding.

1.5 ACTION SUBMITTALS

A. Shop Drawings: Where integrated exterior mockups are required and indicated on the Drawings, provide plans, sections, and elevations, indicating materials and size of mockup construction.

1. Indicate manufacturer and model number of individual components.
2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect/Engineer.
2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect/Engineer.

B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.7 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.

4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For University's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.8 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

1. Monitor quality control over products, services, site conditions, and workmanship to produce work of specified quality.
2. Comply fully with manufacturers' instructions, including each step in sequence.
3. If manufacturers' instructions conflict with Contract Document requirements, request clarification from Architect/Engineer before proceeding.

4. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
5. Perform work by persons qualified to produce workmanship of specified quality.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Subcontractor and Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance. In addition comply with the following:

1. For all trades: Proof of applicable licensing.
2. Electrical contractors:

    a. Company: State of Colorado master electrician license.
    b. On-site electricians: State of Colorado journeyman license.

3. Plumbing Contractors:

    a. Company: State of Colorado master plumbers license.
    b. On-site plumbers: State of Colorado journeyman license.
    c. Gas piping installations: State of Colorado master plumber with minimum 5 years institutional or heavy commercial gas piping experience. Provide an on-site supervisor with a minimum of 3 years of supervisory experience.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329 or ASTM D 3740 as appropriate; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
3. Independent Agency: Meeting “Recommended Requirements for Independent Laboratory Qualifications” published by American Council for Independent Laboratories.
4. Authorized to operate in the State of Colorado.

5. Calibrate testing equipment at reasonable intervals with devices of accuracy traceable to National Bureau of Standards or of accepted values of natural physical constants.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

    a. Provide test specimens representative of proposed products and construction.
    b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    d. When required, build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
    e. When required, build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
    f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups, as applicable; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect/Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect/Engineer.
2. Notify Architect/Engineer seven calendar days in advance of dates and times when mockups will be constructed.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Architect/Engineer's approval of mockups before starting work, fabrication, or construction.

    a. Allow seven calendar days for initial review and each re-review of each mockup.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed unless otherwise indicated.

L. Integrated Exterior Mockups: When indicated on Drawings, construct integrated exterior mockup. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

M. Room Mockups: When indicated on Drawings, construct room mockups incorporating required materials and assemblies, finished according to requirements. Provide required lighting and additional lighting where required to enable Architect/Engineer to evaluate quality of the Work. Provide room mockups of the following rooms:

N. Laboratory Mockups: When required by individual Specification Sections, comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.9 QUALITY CONTROL

A. University Responsibilities: Where quality-control services are indicated as University's responsibility, University will engage a qualified testing agency to perform these services.

1. University will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Payment for these services will be made by the University.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to University are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by University, unless agreed to in writing by University.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect/Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect/Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples including, but not limited to, safe storage and proper curing of concrete test cylinders at Project site for first 24 hours after casting as required by ASTM C 31.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Manufactured Items and Equipment: Where manufactured products or equipment are required to have representative samples tested, do not use such materials or equipment until tests have been made and the materials or equipment found to be acceptable. Do not incorporate in the work any product which becomes unfit for use after acceptance.

J. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to University, Architect/Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.10 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: University will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of University, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect/Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect/Engineer with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections including instructions received from University. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect/Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.
5. Disposition: Pass, fail, nature of defects, if any.
6. Date and descriptions of remedial or correction action taken.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect/Engineer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

3.3 SCHEDULE OF INSPECTIONS AND TESTS BY UNIVERSITY

A. University will engage testing agency and pay for testing and inspection associated with the following materials and systems, where included in the Project:

1. Compaction density of fill and backfill.
2. Drilled pier end bearing conditions and depths.
3. Cast-in-place concrete.
4. Precast concrete.
5. Post-tensioned concrete tendons.
6. Masonry.
7. Structural steel field welds and bolted connections.
8. Spray-applied fireproofing.
9. Built-up roof cutouts.
10. Asphaltic concrete paving.
11. Foundation drainage systems.
12. Drainage structures and piping.
13. Waterproofing.
14. Air barriers.
15. Fluid applied membranes.
16. Thermal imaging.
17. Curtain wall, window, and door field testing.
18. Ceiling hanger wire pull-out.
19. Electrical resistance of static-control resilient flooring.
20. Field sound testing of operable partitions.
21. Elevator safety.
22. Fan vibration.

END OF SECTION 01 40 00

SECTION 01 41 00 REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Building Department Authority.
2. MS 4 Storm Water and Water Quality Permits
3. Applicable Codes and Standards.

1.3 BUILDING DEPARTMENT AUTHORITY

A. The University of Colorado Denver is charged with the responsibility of ensuring that provision of applicable codes, standards and guidelines are met on its campuses.

B. The University Denver campus has an established Building Authority responsible to review and examine buildings and plan documents, to permit and inspect construction and/or demolition to ensure conformance to codes adopted by the University and issue certificates of temporary occupancy and occupancy if satisfactory conformance is demonstrated.

C. The authority is executed by the Campus Building Official (CBO) who has the responsibility to perform all the duties set forth in the Current Approved State Buildings Codes and other applicable codes and standards indicated in the “Applicable Codes and Standards” Article of this Section.

D. Permits: Obtain a separate permit for each Project from the Office of the CBO prior to erecting, constructing, enlarging, repairing, moving, removing, converting or demolishing any building or portion thereof. Coordinate and obtain all permits through the University Project Manager. The Contractor is not responsible for costs associated with construction permits.

1. Exempt work: A building permit is not required for the following:

a. Fences less than or equal to 6 feet tall.
b. Movable casework, counters and partitions not over 5 feet 9 inches tall with no electrical or plumbing.
c. Platforms, walks, and driveways not more than 30 inches above grade and not over any basement or story below.
d. Painting, papering and similar finish work.
e. Other work of limited scope at the discretion of the CBO.

E. Permit Issuance: The CBO, or at the discretion of the CBO a third party code consultant, will review application, Drawings, Specifications, computations and other data filed for permit. Complete the permit

application with the University Project Manager. Permits require submittal of two (2) stamped, signed sets of Construction Documents, including Drawings, Specifications and all Addenda, and one (1) set of each engineering discipline's calculations, where such calculations are required. If CBO determines that submittal conforms to the requirements of the Building Code and other applicable codes, standards, laws, regulations and ordinances, an inspection record card will be issued with the building permit. Keep one stamped set of documents on site. The University will keep one stamped set in the Campus Support plan room.

F. Suspension or Revocation of Permit: CBO may, in writing, suspend or revoke a permit issued in error or on the basis of submitted information that is incorrect or that is in violation of the Building Code and other applicable codes and standards.

G. Posting of Permit: Post the Permit in a visible and protected location near the access to the project.

H. Inspection Record Card: Post the Inspection Record Card next to the permit in a visible and protected location near the access to the project. CBO will make required entries based on inspection of the work.

I. Inspection Requests:

1. Notify CBO that work is ready for inspection two business days before such inspection is desired by telephoning the number posted on the permit. The CBO retains the right to require requests in writing.
2. A re-inspection fee may be charged for prior rejected items.

J. Construction Inspections:

1. Contractor is not responsible for costs associated with construction inspections, except re-inspections. The CBO or his/her designee will perform all general building, electrical and plumbing inspections. All construction or work for which a permit is required must remain accessible and exposed for inspection purposes. Provide access to and means for inspection of work.

2. Site Utilities: Contact and comply with all requirements of City of Aurora.

3. Plumbing and Electrical Inspections: For new buildings and major additions, contact and comply with all requirements of State of Colorado Plumbing and Electrical Boards.

4. Provisions for structural and other special inspections required by Contract Documents, current approved State Building Codes and University Codes will be provided by the University.

K. Certification of Occupancy:

1. When CBO inspects the project and finds no violations of any provision of the Building Code, other applicable codes, standards, laws, regulations and ordinances, CBO will issue a Certification of Occupancy (CO) which will contain the following:

    a. Building permit number.
    b. Address of building.
    c. Name and address of Owner.
    d. Description of building or portion thereof for which certification is issued.
    e. Statement that described building or portion thereof has been inspected for compliance with the requirements of the Building Code, other applicable codes, standards, laws, regulations and ordinances, as relates to type of occupancy and use for which the building is intended.

2. Temporary Certificate of Occupancy (TCO): If CBO finds no substantial hazard will result from occupancy of any building or portion thereof before the same is completed, CBO may issue a TCO for the use of a portion or portions of a building or structure prior to the completion of the entire building or structure.

3. Posting of CO: Provide a copy to the University Project Manager and post in a conspicuous location on the premises. CO may not be removed except by CBO upon initial occupancy.

4. Revocation of CO:

1.4 MS4 STORM WATER AND WATER QUALITY PERMITS

A. The University has a non-standard MS4 permit for entire Anschutz Medical Campus (AMC) that requires University over-sight of campus construction and its water quality impact. Contractors are required to prepare Storm Water Quality Plans and obtain State of Colorado CDPHE permits for all projects that impact site. In addition, Contractors shall comply with the University MS4 permit requirements, including keeping written record of weekly inspections of Storm Water Quality measures and attaching record to the weekly Progress Meeting minutes. Submit the plan, permits, and evidence of final closeout to University Project Manager who will copy all such storm water documents to University Engineering Department. Coordinate with University Project Manager who will arrange for University Grounds Manager to attend monthly inspections and closeout walk.

1.5 APPLICABLE CODES AND STANDARDS

A. The following approved building codes and standards have been adopted by State Buildings Programs (SBP) as the minimum requirements to be applied to all state-owned buildings and physical facilities including capital construction and controlled maintenance construction projects. Current applicable codes can be obtained from The Office of the State Architect's website.

B. University of Colorado Denver Codes and Standards: The following codes and standards supplement those indicated on the Office of the State Architect website.

1. The Manual of Guidelines and Standards for Construction Projects

   a. http://ucdenver.edu/about/departments/FacilitiesManagement/FacilitiesProjects/Pages/GuidelinesStandards.aspx

2. Colorado Rules and Regulations pertaining to Radiation Control, 6 CCR 1007 Part 1-20.
3. Colorado Rules and Regulations pertaining Air Quality Control Commission Regulations, 5 CCR 1001-10, Part B "Asbestos Control."
4. Colorado Rules and Regulations pertaining to Solid Waste, 6 CCR 1007-2.
5. Colorado Rules and Regulations pertaining to Hazardous Waste, 6 CCR 1007-3.
6. Federal Hazardous Waste Regulations, 40 CFR, Parts 260 through 264.
7. Federal Clean Water Act (CWA) is 33 U.S.C § 1251 et seq. (1972).
8. University of Colorado Denver | Anschutz Medical Campus, Asbestos Contaminated Soil Management, Standard Operating Procedure (SOP) Document.
9. NFPA 30: Flammable and Combustible Liquids Code.
10. NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals.
11. NFPA 72: National Fire Alarm and Signaling Code.
12. Life Safety Code (NFPA 101) – latest edition.

    a. Use the most restrictive interpretation where NFPA 101 conflicts with the IBC requirements.

13. ANSI/AIHA Z9.5 Laboratory Ventilation – latest edition.

    a. http://www.aiha.org/insideaiha/standards/Pages/ANSIZ9.aspx

14. ANSI/AIHA Z9.6 Exhaust Systems for Grinding, Buffing and Polishing – latest edition.

    a. http://www.aiha.org/insideaiha/standards/Pages/ANSIZ9.aspx

15. ANSI/AIHA Z9.10 Fundamentals Governing the Design and Operation of Dilution Ventilation Systems in Industrial Occupancies – latest edition.

    a. http://www.aiha.org/insideaiha/standards/Pages/ANSIZ9.aspx

16. ANSI/ASHRAE/ASHE Standard 170 – Ventilation of Healthcare Facilities – latest edition.
17. ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality.
18. OSHA "Safety and Health Regulation for Construction" (29 CFR 1926).
19. OSHA "Occupational Safety and Health Standards" (29 CRF 1910).
20. American Institute of Architects, Academy of Architecture for Health (AIA AAHA) and Facility Guidelines Institute (FGI), Guidelines for Design and Construction of Hospital and Healthcare Facilities – latest edition (FOR PATIENT CARE AREAS ONLY).
21. CDC-NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL); latest edition.
22. NIH Design Requirements Manual (DRM) – latest edition.

    a. http://orf.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/DesignRequirementsManualPDF.htm

23. NIH Guidelines for Research Involving Recombinant DNA Molecules – latest edition.
24. ILAR Guide for Care and Use of Laboratory Animals - latest edition.
25. National Research Council of the National Academies, Institute for Laboratory Animal Research, Division on Earth and Life Studies: Guide for the Care and Use of Laboratory Animals - latest edition.
26. Uniform Federal Accessibility Standards (UFAS) – latest edition.
27. Metro Wastewater District's Rules and Regulations, (Sections 6.17 [6.13, 6.14] and 6.18).
28. City of Aurora Asphalt and Paving Standards - latest edition.

C. Other Standards: As indicated in individual Specification Sections.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 41 00

SECTION 01 42 00 REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Definitions.
2. Industry Standards.
3. Abbreviations and Acronyms.

B. Related Requirements:

1. Section 01 10 00 “Summary” for an explanation of specification and drawing conventions.
2. Section 01 41 00 “Regulatory Requirements” for a list of applicable codes.

1.3 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

1. Definitions in this Section are not intended to be complete, exhaustive or exclusive. They are general and apply to the Work to the extent that such definitions are not stated more explicitly in other provisions of the Contract Documents.

B. "Approved": When used to convey Architect/Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect/Engineer's duties and responsibilities as stated in the Conditions of the Contract. Except where expressly indicated, such approval does not release the Contractor from responsibility to fulfill requirements of the Contract Documents.

C. “Backup”: N+1 system.

D. "Directed": A command or instruction by Architect/Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

E. “EHS”: Environmental Health and Safety.

F. “Engineer”: Architect/Engineer. Other terms including “Mechanical Engineer”, “Electrical Engineer”, or “Structural Engineer” have the same meaning as “Engineer.”

G. "General Conditions": Contract terms contained in Contractor's Agreement Design/Bid/Build, State Form SC-6.21 and The General Conditions of the Construction Contract Design/Bid/Build, State Form SC-6.23

H. "General Requirements": Provisions and requirements of all Division 01 Sections as they apply to all aspects of the Work.

I. "Guarantee": The narrow definition of the term "warranty" applying to both "warranty" and "guarantee" which terms are used interchangeably.

J. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

K. "Redundant": 2N system. The level of redundancy is determined by design.

L. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work, whether lawfully imposed by authorities having jurisdiction or not.

M. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

N. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

O. "Owner": Principal Representative and/or University.

P. "Provide": Furnish and install, complete and ready for the intended use.

Q. "Project Manual": Bound, printed volume or volumes including Conditions of the Contract and Specifications, which may also include bidding requirements, contract forms, details, schedules, surveys, reports or other relevant items that may or may not be Contract Documents.

R. "Project Site": Space available for performing construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

S. "Supplementary Conditions": University Special Supplementary General Conditions. Other terms including "Supplementary General Conditions" shall have the same meaning.

1.4 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1. Referenced standards take precedence over standards that are not referenced but generally recognized in the construction industry as applicable.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents.

1. Updated Codes and Standards: Where an applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected, submit Contractor-Initiated Change Order Bulletin and Change Order Proposal in accordance with Section 01 26 00 “Contract Modification Procedures” for consideration to modify contract requirements to comply with revised code or standard.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.
2. Where required by individual Specification Sections provide and maintain copies of referenced codes and standards at Project Site.
3. Although copies of standards needed for enforcement of requirements may be part of required submittals, the Architect/Engineer reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

D. Unreferenced Standards: Unreferenced standards are not directly applicable to the Work, except as a general requirement of whether the Work complies with recognized construction industry standards.

E. Conflicting Requirements: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Architect/Engineer for a decision before proceeding.

1.5 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AABC	Associated Air Balance Council www.aabc.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials www.transportation.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association www.americanbearings.org	(202) 367-1155
ACI	American Concrete Institute (Formerly: ACI International) www.concrete.org	(248) 848-3700

ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AF&PA	American Forest & Paper Association	(800) 878-8878
	www.afandpa.org	(202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The) www.ahrinet.org	(703) 524-8800
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The)	(800) 242-3837
	www.aia.org	(202) 626-7300
AISC	American Institute of Steel Construction	(800) 644-2400
	www.aisc.org	(312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction www.aitc-glulam.org	(303) 792-9559
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts, Inc. www.aosaseed.com	(607) 256-3313
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute (See AHRI)	

ARI	American Refrigeration Institute (See AHRI)	
ARMA	Asphalt Roofing Manufacturers Association www.asphaltroofing.org	(202) 207-0917
ASCE	American Society of Civil Engineers	(800) 548-2723
	www.asce.org	(703) 295-6300
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers	(800) 527-4723
	www.ashrae.org	(404) 636-8400
ASME	ASME International	(800) 843-2763
	(American Society of Mechanical Engineers) www.asme.org	(973) 882-1170
ASSE	American Society of Safety Engineers (The) www.asse.org	(847) 699-2929
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9500
ATIS	Alliance for Telecommunications Industry Solutions www.atis.org	(202) 628-6380
AWEA	American Wind Energy Association www.awea.org	(202) 383-2500
AWI	Architectural Woodwork Institute www.awinet.org	(571) 323-3636
AWMAC	Architectural Woodwork Manufacturers Association of Canada www.awmac.com	(403) 453-7387
AWPA	American Wood Protection Association (Formerly: American Wood-Preservers' Association) www.awpa.com	(205) 733-4077
AWS	American Welding Society	(800) 443-9353
	www.aws.org	(305) 443-9353
AWWA	American Water Works Association	(800) 926-7337
	www.awwa.org	(303) 794-7711

BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122

BIA	Brick Industry Association (The) www.gobrick.com	(703) 620-0010
BICSI	BICSI, Inc.	(800) 242-7405
	www.bicsi.org	(813) 979-1991
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association) www.bifma.com	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee www.bissc.org	(866) 342-4772
BOCA	BOCA (Building Officials and Code Administrators International Inc.) (See ICC)	
BWF	Badminton World Federation (Formerly: International Badminton Federation) www.bwfbadminton.org	60 3 9283 7155
CDA	Copper Development Association	(800) 232-3282
	www.copper.org	(212) 251-7200
CEA	Canadian Electricity Association www.electricity.ca	(613) 230-9263
CEA	Consumer Electronics Association	(866) 858-1555
	www.ce.org	(703) 907-7600
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CFSEI	Cold-Formed Steel Engineers Institute	(866) 465-4732
	www.cfsei.org	(202) 263-4488
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CIMA	Cellulose Insulation Manufacturers Association	(888) 881-2462
	www.cellulose.org	(937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(404) 622-0073
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPA	Composite Panel Association www.pbmdf.com	(703) 724-1128
CRI	Carpet and Rug Institute (The) www.carpet-rug.org	(706) 278-3176

CRRC	Cool Roof Rating Council www.coolroofs.org	(866) 465-2523 (510) 485-7175
CRSI	Concrete Reinforcing Steel Institute	(800) 328-6306
	www.crsi.org	(847) 517-1200
CSA	Canadian Standards Association	(800) 463-6727
	www.csa.ca	(416) 747-4000
CSA	CSA International	(866) 797-4272
	(Formerly: IAS - International Approval Services) www.csa-international.org	(416) 747-4000
CSI	Construction Specifications Institute (The)	(800) 689-2900
	www.csinet.org	(703) 684-0300
CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
CWC	Composite Wood Council (See CPA)	
DASMA	Door and Access Systems Manufacturers Association www.dasma.com	(216) 241-7333
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
ECA	Electronic Components Association www.ec-central.org	(703) 907-8024
ECAMA	Electronic Components Assemblies & Materials Association (See ECA)	
EIA	Electronic Industries Alliance (See TIA)	
EIMA	EIFS Industry Members Association	(800) 294-3462
	www.eima.com	(703) 538-1616
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association (Electrostatic Discharge Association) www.esda.org	(315) 339-6937
ESTA	Entertainment Services and Technology Association (See PLASA)	

EVO	Efficiency Valuation Organization www.evo-world.org	(415) 367-3643 44 20 88 167 857
FIBA	Fédération Internationale de Basketball (The International Basketball Federation) www.fiba.com	41 22 545 00 00
FIVB	Fédération Internationale de Volleyball (The International Volleyball Federation) www.fivb.org	41 21 345 35 45
FM Approvals	FM Approvals LLC www.fmglobal.com	(781) 762-4300
FM Global	FM Global (Formerly: FMG - FM Global) www.fmglobal.com	(401) 275-3000
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridaroof.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council U.S. www.fscus.org	(612) 353-4511
GA	Gypsum Association www.gypsum.org	(301) 277-8686
GANA	Glass Association of North America www.glasswebsite.com	(785) 271-0208
GS	Green Seal www.greenseal.org	(202) 872-6400
HI	Hydraulic Institute www.pumps.org	(973) 267-9700
HI/GAMA	Hydronics Institute/Gas Appliance Manufacturers Association (See AHRI)	
HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAPSC	International Association of Professional Security Consultants www.iapsc.org	(415) 536-0288

IAS	International Approval Services (See CSA)	
ICBO	International Conference of Building Officials (See ICC)	
ICC	International Code Council	(888) 422-7233
	www.iccsafe.org	(202) 370-1800
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(770) 830-0369
ICPA	International Cast Polymer Alliance www.icpa-hq.org	(703) 525-0511
ICRI	International Concrete Repair Institute, Inc. www.icri.org	(847) 827-0830
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IES	Illuminating Engineering Society (Formerly: Illuminating Engineering Society of North America) www.ies.org	(212) 248-5000
IESNA	Illuminating Engineering Society of North America (See IES)	
IEST	Institute of Environmental Sciences and Technology www.iest.org	(847) 981-0100
IGMA	Insulating Glass Manufacturers Alliance www.igmaonline.org	(613) 233-1510
IGSHPA	International Ground Source Heat Pump Association www.igshpa.okstate.edu	(405) 744-5175
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
Intertek	Intertek Group (Formerly: ETL SEMCO; Intertek Testing Service NA) www.intertek.com	(800) 967-5352
ISA	International Society of Automation (The) (Formerly: Instrumentation, Systems, and Automation Society) www.isa.org	(919) 549-8411
ISAS	Instrumentation, Systems, and Automation Society (The) (See ISA)	

ISFA	International Surface Fabricators Association (Formerly: International Solid Surface Fabricators Association) www.isfanow.org	(877) 464-7732 (801) 341-7360
ISO	International Organization for Standardization www.iso.org	41 22 749 01 11
ISSFA	International Solid Surface Fabricators Association (See ISFA)	
ITU	International Telecommunication Union www.itu.int/home	41 22 730 51 11
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LMA	Laminating Materials Association (See CPA)	
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MCA	Metal Construction Association www.metalconstruction.org	(847) 375-4718
MFMA	Maple Flooring Manufacturers Association, Inc. www.maplefloor.org	(888) 480-9138
MFMA	Metal Framing Manufacturers Association, Inc. www.metalframingmfg.org	(312) 644-6610
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(440) 250-9222
MMPA	Moulding & Millwork Producers Association (Formerly: Wood Moulding & Millwork Producers Association) www.wmmpa.com	(800) 550-7889 (530) 661-9591
MPI	Master Painters Institute www.paintinfo.com	(888) 674-8937 (604) 298-7578
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.org	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(630) 942-6591

NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(800) 797-6223 (281) 228-6200
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAIMA	North American Insulation Manufacturers Association www.naima.org	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCAA	National Collegiate Athletic Association (The) www.ncaa.org	(317) 917-6222
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association	(888) 300-6382
	www.netaworld.org	(269) 488-6382
NFHS	National Federation of State High School Associations www.nfhs.org	(317) 972-6900
NFPA	NFPA	(800) 344-3555
	(National Fire Protection Association) www.nfpa.org	(617) 770-3000
NFPA	NFPA International (See NFPA)	
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NHLA	National Hardwood Lumber Association	(800) 933-0318
	www.nhla.com	(901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association (See NWFA)	

NOMMA	National Ornamental & Miscellaneous Metals Association www.nomma.org	(888) 516-8585
NRCA	National Roofing Contractors Association	(800) 323-9545
	www.nrca.net	(847) 299-9070
NRMCA	National Ready Mixed Concrete Association	(888) 846-7622
	www.nrmca.org	(301) 587-1400
NSF	NSF International	(800) 673-6275
	(National Sanitation Foundation International) www.nsf.org	(734) 769-8010
NSPE	National Society of Professional Engineers	(703) 684-2800
	www.nspe.org	
NSSGA	National Stone, Sand & Gravel Association	(800) 342-1415
	www.nssga.org	(703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. (The)	(800) 323-9736
	www.ntma.com	
NWFA	National Wood Flooring Association	(800) 422-4556
	www.nwfa.org	(636) 519-9663
PCI	Precast/Prestressed Concrete Institute	(312) 786-0300
	www.pci.org	
PDI	Plumbing & Drainage Institute	(800) 589-8956
	www.pdionline.org	(978) 557-0720
PLASA	PLASA	(212) 244-1505
	(Formerly: ESTA - Entertainment Services and Technology Association) www.plasa.org	
RCSC	Research Council on Structural Connections	
	www.boltcouncil.org	
RFCI	Resilient Floor Covering Institute	(706) 882-3833
	www.rfci.com	
RIS	Redwood Inspection Service	(925) 935-1499
	www.redwoodinspection.com	
SAE	SAE International	(877) 606-7323
	(Society of Automotive Engineers) www.sae.org	(724) 776-4841
SBCCI	Southern Building Code Congress International, Inc.	
	(See ICC)	
SCTE	Society of Cable Telecommunications Engineers	(800) 542-5040
	www.scte.org	(610) 363-6888

SDI	Steel Deck Institute www.sdi.org	(847) 458-4647
SDI	Steel Door Institute	(440) 899-0010
	www.steeldoor.org	
SEFA	Scientific Equipment and Furniture Association	(877) 294-5424
	www.sefalabs.com	(516) 294-5424
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)	
SIA	Security Industry Association	(866) 817-8888
	www.siaonline.org	(703) 683-2075
SJI	Steel Joist Institute	(843) 293-1995
	www.steeljoist.org	
SMA	Screen Manufacturers Association	(773) 636-0672
	www.smainfo.org	
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association	(703) 803-2980
	www.smacna.org	
SMPTE	Society of Motion Picture and Television Engineers	(914) 761-1100
	www.smpte.org	
SPFA	Spray Polyurethane Foam Alliance	(800) 523-6154
	www.sprayfoam.org	
SPIB	Southern Pine Inspection Bureau	(850) 434-2611
	www.spib.org	
SPRI	Single Ply Roofing Industry	(781) 647-7026
	www.spri.org	
SRCC	Solar Rating and Certification Corporation	(321) 638-1537
	www.solar-rating.org	
SSINA	Specialty Steel Industry of North America	(800) 982-0355
	www.ssina.com	(202) 342-8630
SSPC	SSPC: The Society for Protective Coatings	(877) 281-7772
	www.sspc.org	(412) 281-2331
STI	Steel Tank Institute	(847) 438-8265
	www.steeltank.com	
SWI	Steel Window Institute	(216) 241-7333
	www.steelwindows.com	
SWPA	Submersible Wastewater Pump Association	(847) 681-1868
	www.swpa.org	

TCA	Tilt-Up Concrete Association www.tilt-up.org	(319) 895-6911
TCNA	Tile Council of North America, Inc. (Formerly: Tile Council of America) www.tileusa.com	(864) 646-8453
TEMA	Tubular Exchanger Manufacturers Association, Inc. www.tema.org	(914) 332-0040
TIA	Telecommunications Industry Association (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance) www.tiaonline.org	(703) 907-7700
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance (See TIA)	
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute www.tpinst.org	(703) 683-1010
TPI	Turfgrass Producers International	(800) 405-8873
	www.turfgrasssod.org	(847) 649-5555
TRI	Tile Roofing Institute www.tileroofing.org	(312) 670-4177
UBC	Uniform Building Code (See ICC)	
UL	Underwriters Laboratories Inc. www.ul.com	(877) 854-3577
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USAV	USA Volleyball	(888) 786-5539
	www.usavolleyball.org	(719) 228-6800
USGBC	U.S. Green Building Council www.usgbc.org	(800) 795-1747
USITT	United States Institute for Theatre Technology, Inc.	(800) 938-7488
	www.usitt.org	(315) 463-6463
WASTEC	Waste Equipment Technology Association	(800) 424-2869
	www.wastec.org	(202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau	(800) 283-1486
	www.wclib.org	(503) 639-0651

WCMA	Window Covering Manufacturers Association www.wcmanet.org	(212) 297-2122
WDMA	Window & Door Manufacturers Association	(800) 223-2301
	www.wdma.com	(312) 321-6802
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California) www.wicnet.org	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association (See MMPA)	
WSRCA	Western States Roofing Contractors Association	(800) 725-0333
	www.wsrca.com	(650) 938-5441
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DIN	Deutsches Institut für Normung e.V. www.din.de	49 30 2601-0
IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
ICC	International Code Council www.iccsafe.org	(888) 422-7233
ICC-ES	ICC Evaluation Service, LLC	(800) 423-6587
	www.icc-es.org	(562) 699-0543

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

COE	Army Corps of Engineers www.usace.army.mil	(202) 761-0011
CPSC	Consumer Product Safety Commission	(800) 638-2772
	www.cpsc.gov	(301) 504-7923
DOC	Department of Commerce National Institute of Standards and Technology www.nist.gov	(301) 975-4040
DOD	Department of Defense http://dodssp.daps.dla.mil	(215) 697-2664
DOE	Department of Energy www.energy.gov	(202) 586-9220

EPA	Environmental Protection Agency www.epa.gov	(202) 272-0167
FAA	Federal Aviation Administration www.faa.gov	(866) 835-5322
FG	Federal Government Publications www.gpo.gov	(202) 512-1800
GSA	General Services Administration	(800) 488-3111
	www.gsa.gov	(202) 619-8925
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley National Laboratory Environmental Energy Technologies Division http://eetd.lbl.gov	(510) 486-4000
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742
SD	Department of State www.state.gov	(202) 647-4000
TRB	Transportation Research Board National Cooperative Highway Research Program www.trb.org	(202) 334-2934
USDA	Department of Agriculture Agriculture Research Service U.S. Salinity Laboratory www.ars.usda.gov	(202) 720-3656
USDA	Department of Agriculture Rural Utilities Service www.usda.gov	(202) 720-2791
USDJ	Department of Justice Office of Justice Programs National Institute of Justice www.ojp.usdoj.gov	(202) 307-0703
USP	U.S. Pharmacopeia	(800) 227-8772
	www.usp.org	(301) 881-0666
USPS	United States Postal Service www.usps.com	(202) 268-2000

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CFR	Code of Federal Regulations Available from Government Printing Office www.gpo.gov/fdsys	(866) 512-1800 (202) 512-1800
DOD	Department of Defense	(215) 697-2664
	Military Specifications and Standards Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	
DSCC	Defense Supply Center Columbus	
	(See FS)	
FED-STD	Federal Standard	
	(See FS)	
FS	Federal Specification	(215) 697-2664
	Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	
	Available from Defense Standardization Program	
	www.dsp.dla.mil	
	Available from General Services Administration	(800) 488-3111
	www.gsa.gov	(202) 619-8925
	Available from National Institute of Building Sciences/Whole Building Design Guide www.wbdg.org/ccb	(202) 289-7800
MILSPEC	Military Specification and Standards	
	(See DOD)	
USAB	United States Access Board	(800) 872-2253
	www.access-board.gov	(202) 272-0080
USATBCB	U.S. Architectural & Transportation Barriers Compliance Board	
	(See USAB)	

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 50 00 TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1. Nothing in this Section is intended to limit types and amounts of temporary work required, and no omission from this Section will be recognized as an indication by Architect/Engineer that such temporary activity is not required for successful completion of the Work. The use of alternative facilities equivalent to those specified is the Contractor's option, subject to Architect/Engineer's and University acceptance.

B. Related Requirements:

1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.
2. Section 01 35 46 “Indoor Air Quality” for temporary facility work including HVAC, air filtration, moisture management, air filtration and dust control partitions required to comply with indoor air quality requirements during construction.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, University's construction forces, Architect/Engineer, testing agencies, and authorities having jurisdiction.

B. Use Charges: As follows:

1. For new construction: Arrange for and pay for water, sewer, electric power, steam and chilled water use charges for utility usage by all entities for construction operations.
2. For renovations of existing facilities: Arrange for and University will pay for all use charges.

C. Temporary Metering: For all utility connection; sub-meter at point of connection to existing systems.

1. Temporary utility meter must be approved by University Campus Energy Engineer.
2. Meters shall be operational prior to any use of utility for temporary heating.

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

D. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste handling procedures.
5. Other dust-control measures.

1.5 QUALITY ASSURANCE

A. General: Comply with governing regulations and utility company regulations and recommendations for the construction of temporary facilities including, but not necessarily limited to, code compliances, permits, inspections, testing, health, safety, pollution and environmental compliances.

B. Fire-safety: Comply with NFPA 421 “Standard for Safeguarding Construction, Alteration, and Demolition Operations.”

C. Safety: Comply with ANSI/ASSE A10 “Construction Package” series of safety construction standards.

D. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

E. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

F. Accessible Temporary Egress: Where temporary accessible egress from existing buildings or portions thereof is provided, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before University's acceptance, regardless of previously assigned responsibilities.

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide both new or used materials and equipment for temporary facilities, which are in substantially undamaged and serviceable condition. Provide types and qualities which are recognized in the construction industry as suitable for the intended use in each application. Comply with Utility Company requirements as applicable.

2.2 TEMPORARY FACILITIES

A. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.
2. Comply with Section 01 10 00 “Summary” for use of site for staging areas.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. Digital Camera: Minimum 12 megapixel; available in field office for use.

C. Thermometer: Outdoor, re-settable type indicating daily maximum and minimum temperatures.

1. Locate in a shaded-from-the-sun, conveniently readable location that will give reasonably accurate readings of the actual air temperature and be reached easily for resetting.
2. Maintain daily log of reading.

D. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate, expand and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

C. Use qualified workers for the installation of temporary facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. Heating: Provide temporary heating required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high

humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. HVAC Equipment: Unless University authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

    a. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
    b. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
    c. Permanent HVAC System: If University authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air and exhaust grille in system and remove at end of construction. Clean and adjust HVAC system and put in new condition before Completion as required in Section 01 77 00 "Closeout Procedures".

B. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.

    a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
    b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

C. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.

D. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Provide temporary light to levels and as required by governing regulations but not less than minimum 5 foot-candle illumination in all areas accessible to workers during hours they are at the job; minimum 10 foot-candles for shop areas; 20 foot-candles or more where detailed or finishing work is being done, supplemented as may be required.
2. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
3. Install lighting for Project identification sign.
4. Where permanent light fixtures have been used for temporary lighting, supply temporary lamps and replace with new lamps at time of Completion.
5. Provide lighting in stairways and exits at all times.

3.3 SUPPORT FACILITIES INSTALLATION

A. Temporary Walks: Construct and maintain temporary walks around the construction work and to offices, toilets and similar locations on the site.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

C. Parking: Comply with requirements in Section 01 10 00 “Summary.”

D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

E. Project Signs: Provide Project signs at locations indicated or directed. Unauthorized signs are not permitted.

1. Identification Signs: Unless otherwise indicated, provide 4 foot by 8 foot Project identification sign.

a. Architect/Engineer will provide sign layout, including colors and graphics as approved by University Resident Architect through University Project Manager.

2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Engage an experience sign painter to apply required colors and graphics in a neat and professional manner.
4. Maintain and touchup signs so they are legible at all times.

F. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel. The selection of type, size and number of hoisting facilities is the solely the responsibility of the Contractor.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

G. Existing Elevator Use: When approved by University, one designated existing elevator may be used at no charge to Contractor or other subcontractors for transporting personnel, small tools, materials, and equipment. Comply with requirements of Section 01 10 00 “Summary” and the following:

1. Contractor will not be granted exclusive use of the designated elevator. University personnel and staff will be permitted to use this elevator as their work duties require.
2. Entire car is lined (floor, walls, ceiling) with 3/4 inch Fir plywood or equivalent.
3. Total load carried does not exceed rated capacity of elevator.
4. No materials, equipment, trash, tools or other items too large to be readily moved into and out of the car may be carried in the elevator.
5. Before acceptance of the building, linings are removed; all exposed surfaces are in new condition;

all controls, relays, other parts showing any wear have been replaced.

6. Entire elevator, including machinery, electrical components, doors, operators and controls shall be tested, adjusted, and put in new condition with specified warranties and maintenance to take effect at date of Completion Certificate.
7. Written clearance has been obtained from the Elevator Service Company stating that the installation is safe and complete for this use prior to using it.
8. The Contractor signs the Elevator Service Company's standard agreement and release forms for this usage and pays charges for maintenance, service, repairs, and reconditioning.

H. Existing Stair Usage: Use of University's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to University. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

I. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Protection of Work: Protect in-progress and completed work from damage or deterioration, other than normal weathering of exposed materials, through construction duration until completion, as appropriate and as recommended by manufacturer and Installer.

1. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings. Protect finished floors and stairs from traffic, movement of heavy objects, and storage.
2. Prohibit traffic and storage on waterproofed and roofed surfaces, on lawn and landscaped areas.
3. Always protect excavation, trenches, and building, from damage from rain water, spring water, ground water, backing up of drains or sewers. Provide pumps, equipment, enclosures, to provide this protection.
4. Remove protective coverings and materials at the appropriate time but no later than final cleaning operations.

C. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 01 10 00 "Summary."

D. Security: Provide security program and facilities to protect the Work, existing facilities, and University operations and to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

1. Coordinate with University Police.
2. Provide lockable entrances and lock entrances at end of each work day.
3. After review and approval by University, install temporary enclosure around partially completed areas of construction.
4. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

E. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting wherever required to prevent accidents and losses.

F. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

G. Covered Walkway: Where regulations require or where a public roadway/walkway adjoins the Project site and materials may be hoisted across the walkway, erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Construct covered walkways using scaffold or shoring framing.
2. Provide overhead waterproof decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
3. Paint and maintain appearance of walkway for duration of the Work in a manner acceptable to the Architect/Engineer and University.
4. Extend back wall beyond structure to complete the enclosure fence.

H. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
2. Coordinate temporary enclosures with ventilating and drying-of-the-work requirements, so as to avoid dangerous conditions and deleterious effects.
3. Close openings through floor or roof decks and horizontal surfaces with load-bearing wood-framed construction.

I. Temporary Partitions: Provide floor-to-floor or floor-to-ceiling dustproof partitions terminating in dustproof floor or ceiling above to limit dust and dirt migration and to separate existing active elevator hoistways and other areas occupied by University from dust, fumes and noise in compliance with Section 01 35 46 “Indoor Air Quality” and the following:

1. Construct dustproof partitions with 5/8 inch gypsum wallboard with joints taped on occupied side, and 1/2 inch fire-retardant-treated plywood on construction operations side.
2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
3. Insulate partitions to control noise transmission to occupied areas.
4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
5. Protect air-handling equipment.
6. Provide walk-off mats at each entrance through temporary partition.
7. At elevator hoistway entrances not used during construction, seal openings with plastic sheet and duct tape.

J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Fire Extinguishers: Minimum one per floor at or near useable exit.

    a. Provide additional extinguishers where convenient and effective for intended purpose.
    b. Comply with NFPA 10 to the extent applicable.

2. Strictly enforce site prohibition against smoking.
3. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
4. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Coordinate with University Project Manager to review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
5. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.
6. Maintain unobstructed access to fire extinguishers, temporary fire protection facilities, stairways and other access routes for fighting fires.
7. Store combustible materials in containers in fire-safe locations.
8. Permanent Fire Protection System: Complete and make operational at earliest possible date. Instruct site personnel on use of permanent system.

3.5 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Comply with requirements in Section 01 35 46 “Indoor Air Quality Procedures.”

3.6 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

1. Do not permit temporary offices and similar temporary or permanent spaces to be used as living quarters or for other unintended occupancies or uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Janitorial Services: Provide daily janitorial services for temporary offices, toilets, and similar areas at the project site. Require users of other temporary facilities to maintain clean and orderly premises.

D. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.

E. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

F. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion, unless Architect/Engineer requests that it be retained for a longer period of time. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. University reserves right to take possession of Project identification signs.
2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 60 00 PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Section 01 21 00 "Allowances" for products selected under an allowance, if applicable.
2. Section 01 23 00 "Alternates" for products selected under an alternate, if applicable.
3. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
4. Section 01 42 00 "References" for applicable industry standards for products specified.
5. Section 01 77 00 “Closeout Procedures” for submittal of project warranties.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Requests for consideration of comparable products will only be entertained during bidding.
2. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
3. Architect/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation of a comparable product request. Architect/Engineer will notify Contractor of approval or rejection of proposed comparable product.

a. Form of Approval: Written Addendum.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options. The complete compatibility between the various choices available to the Contractor is not assured by the various requirements of the Contract Documents, but must be provided by the Contractor.

B. Source Limitations: To the fullest extent possible, provide products of the same kind, from a single source.

C. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturers or producer's nameplates or trademarks on exposed surfaces of products which will be exposed to view in occupied spaces or on the exterior.

D. Labels: Locate required product labels and stamps on a concealed surface or, where required for observation after installation, on an accessible surface that is not conspicuous.

E. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface which is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data.

1. Name of product and manufacturer.
2. Model and serial number.
3. Capacity.
4. Speed.
5. Ratings.
6. Power characteristics (if applicable).
7. UL label or compliance (if applicable).

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents. Such disclaimers and limitations do not relieve warranty requirements on Work that incorporates product nor do they relieve suppliers, manufacturers and subcontractors required to countersign special warranties with the Contractor.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to University.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for University.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time and Form: Comply with requirements in Section 01 77 00 "Closeout Procedures."

D. Warranty Requirements:

1. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
2. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
3. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the University has benefited from use of the Work through a portion of its anticipated useful service life.
4. University's Recourse:

    a. Written warranties made to the University are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the University can enforce such other duties, obligations, rights, or remedies.
    b. Rejection of Warranties: The University reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
    c. The University reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged, are asbestos free, and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. University reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect/Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product and provide only products previously approved during bid phase by written Addendum. The determination of equivalence is at the sole discretion of the Architect/Engineer who has no obligation to prove non-equivalence.
7. Mechanical and electrical equipment design and their space requirements are based on the first named item of the Section in which specified or that scheduled on the Drawings. If other than the first named or scheduled item listed for use is selected, modification to other elements of Work may be required. Show all such modification on shop drawings and submittals as appropriate. The cost of such modifications is solely the responsibility of the Contractor.

8. Where manufacturers are listed as acceptable for specific proprietary products but precise identification by model, series, or trade name is not specified, submit detailed product information for such products for Architect/Engineer's acceptance prior to ordering. Include specific requirements for modifications to other construction, including but not limited to, power and utility requirements, characteristics, capacities, size and locations. The cost of such modifications is solely the responsibility of the Contractor.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:

    a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

4. Manufacturers:

    a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. If proposing a comparable product by another manufacturer, whether named or not, provide a custom product if manufacturer’s standard product does not include salient features of the Basis-of-Design product indicated. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
6. Contractor’s Option: Where materials, products, systems or methods are specified to be selected from a list of options, subject to compliance with requirements, the choice of which material, method, product or system will be solely at the Contractor’s discretions. There will be no change in Contract Sum or Time because of such choice.

C. Visual Matching Specification: Where Specifications require "match Architect/Engineer's sample", provide a product that complies with requirements and matches Architect/Engineer's sample. Architect/Engineer's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect/Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect/Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Prior to bid, Architect/Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer will reject request:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of University-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.
9. Correction of the Work.

B. Related Requirements:

1. Section 01 10 00 "Summary" for limits on use of Project site and procedures related to utility interruptions.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor or professional engineer.

B. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.

C. Cutting and Patching Plan and Request: Submit plan and request describing procedures at least 21 calendar days prior to the time cutting and patching will be performed.

1. Submit request whenever cutting and patching operation affect:

a. Work of the University or any separate contractor.
b. Structural value or integrity of any element of the Project.
c. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
d. Efficiency, operational life, maintenance or safety of operational elements.
e. Visual qualities of sight-exposed elements.
f. Cutting new openings in existing structural concrete walls, floors and suspended slabs.
g. Cutting new openings in existing roofs and roofing materials.
h. Cutting exterior walls.
i. Cutting into shafts.

2. Include the following information:

a. Extent: Describe reason for and extent of each occurrence of cutting and patching, including explanation of why cutting and patching operation cannot be reasonable avoided.
b. Changes to In-Place Construction: Describe cutting and patching methods and anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
c. Products: List products to be used for patching and firms or entities that will perform patching work.
d. Trades: Indicate trades and subcontractors who will perform the work.
e. Dates: Indicate when cutting and patching will be performed.
f. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

1) Include description of provisions for temporary services and systems during interruption of permanent services and systems.
2) Comply with requirements of Section 01 10 00 “Summary” related to existing utility and system interruptions.

g. Structural Elements: Where cutting and patching structural elements requires the addition of reinforcement, submit details and calculations signed and sealed by an Engineer registered in the State of Colorado. Indicate how new reinforcing will be integrated with original structure.

3. Limitations: Approval of cutting and patching request does not waive right of Architect/Engineer or University to later require complete removal and replacement of work found to be unsatisfactorily cut and patched.

1.5 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect/Engineer of locations and details of cutting and await directions from Architect/Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance

or decreased operational life or safety. Operational elements include but are not limited to the following:

a. Primary operational systems and equipment.
b. Fire separation assemblies.
c. Air or smoke barriers.
d. Fire-suppression systems.
e. Mechanical systems piping and ducts.
f. Control systems.
g. Communication systems.
h. Fire-detection and -alarm systems.
i. Conveying systems.
j. Electrical wiring systems.
k. Operating systems of special construction.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

a. Water, moisture, or vapor barriers.
b. Membranes and flashings.
c. Exterior curtain-wall construction.
d. Sprayed fire-resistive material.
e. Equipment supports.
f. Piping, ductwork, vessels, and equipment.
g. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction exposed to the exterior or exposed in occupied spaces in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect/Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

5. Hazardous Materials: Do not proceed with cutting and patching operations until University has examined existing construction for the presence of asbestos and/or lead-based coatings. Comply with requirements in Section 01 35 00 “Special Procedures.”

C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with requirements in Division 01 Section “Sustainable Design Requirements.”

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will

provide a match acceptable to Architect/Engineer for the visual and functional performance of in-place materials.

C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work. Notify University Project Manager and Architect/Engineer and obtain approval prior to disturbing, moving or penetrating soil.

1. Arrange for locating buried utilities including water and sewer lines within construction limits. Obtain location information and stake all known utilities prior to commencing construction activities.

a. Contact Utility Notification Center of Colorado (UNCC), 1-800-922-1987, and comply with UNCC guidelines.

2. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
3. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility or University, as appropriate, that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify

dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect/Engineer according to requirements in Section 01 31 00 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect/Engineer promptly.

B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect/Engineer when deviations from required lines and levels exceed allowable tolerances. Record deviation which are accepted (i.e., not corrected) on record drawings in accordance with the requirements of Section 01 78 39 “Project Record Docuements.”
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect/Engineer.

3.4 FIELD ENGINEERING

A. Identification: University will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect/Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect/Engineer before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced

to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated to the extent they are more explicit or stringent than requirements of the Contract Documents.

C. Install products at the time and under conditions, including weather that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Isolate each part of complete installation from incompatible material as needed to prevent deterioration.

E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

G. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

H. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

I. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned, true and level as applicable, with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect/Engineer.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

J. Attachment to Concrete:

1. No drilled inserts or powder-actuated fasteners are permitted in pre-stressed concrete except as specifically authorized by Contractor and carried out under the direct supervision of its Superintendent.
2. Only those devices with a maximum controlled penetration of 3/4 inch or less will be permitted. Make holes through slabs by means of sleeves placed no closer than 2 inch from tensioning cables. Core drilling will not be permitted unless unavoidable and as specified for cutting and patching in this Section.

K. Joints: Unless indicated otherwise, make joints of uniform width. Where joint locations in exposed work are required but not indicated, arrange joints for the best visual effect. Confirm arrangement with Architect/Engineer before proceeding. Fit exposed connections together to form hairline joints.

L. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Responsibility: Provide cutting and patching work, including attendant excavation and backfill required to complete the Work or to:

1. Make components fit together properly.
2. Uncover portions of the Work to provide for installation of ill-timed work.
3. Remove and replace defective work or work not conforming to requirements of Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Provide routine penetrations of non-structural surfaces for installation of piping and electrical conduit.

C. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

D. Temporary Support: Provide temporary support of work to be cut.

E. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

F. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 10 00 "Summary."

G. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas, coordinate cutting and patching according to requirements in Section 01 10 00 "Summary."

H. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written

recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations. Employ methods which will prevent settlement or damage to other work.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

I. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements, including tolerance, specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

J. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 UNIVERSITY-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for University's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by University's construction personnel.

1. Construction Schedule: Inform University of Contractor's preferred construction schedule for University's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify University if changes to schedule are required due to differences in actual construction progress.

2. Preinstallation Conferences: Include University's construction personnel at preinstallation conferences covering portions of the Work that are to receive University's work. Attend preinstallation conferences conducted by University's construction personnel if portions of the Work depend on University's construction.

3.8 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven calendar days during normal weather or three calendar days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Use containers intended for holding waste materials of type to be stored.

B. Collection Point: Review location with University and obtain approval.

C. Site: Maintain Project site free of waste materials and debris.

D. Wind Blown Debris: Prevent spread of trash, debris, cartons, packing material, or other waste on or off Project site by wind.

E. Dust: Sprinkle dusty debris with water.

F. Packing Materials: Immediately after uncrating or unpacking materials or equipment, remove all crating, lumber, excelsior, wrapping or other like combustible materials from building to central collection facility.

G. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

H. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

I. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

J. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

K. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

L. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

M. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

N. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

O. Snow and Ice: Remove snow and ice from sidewalks adjacent to site and from access ways to building and construction site.

P. Streets: At frequency required by University and/or governing authority, clean adjacent and nearby streets of dirt resulting from construction operations.

3.9 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Thermal shock.
5. Excessively high or low humidity.
6. Air contamination or pollution.
7. Water or ice.
8. Solvents.
9. Chemicals.

10. Light.
11. Radiation.
12. Puncture.
13. Abrasion.
14. Heavy traffic.
15. Soiling, staining and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High speed operation.
21. Improper lubrication.
22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Misalignment.
25. Excessive weathering.
26. Unprotected storage.
27. Improper shipping or handling.
28. Theft.
29. Vandalism.

END OF SECTION 01 73 00

SECTION 01 73 05

UTILITY INTERRUPTION – MECHANICAL, ELECTRICAL, PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements governing the shutdown of mechanical, electrical, and plumbing services for proper notification of all impacted by shutdown.

B. Contractor to complete attached outage request and submit to university project manager.

C. Outage requests must be submitted in advance per the time periods identified on attached form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 COORDINATION

A. University staff will coordinate and announce internally to all impacted areas.

B. Contractor & Subcontractors requesting outages must be present at specified time identified in approved outage request to initiate the start of outage. If contractors are not present, outage may be postponed.

C. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

END OF SECTION 01 73 05

University of Colorado
Anschutz Medical Campus

Facilities Management

UTILITY INTERRUPTION/ SHUTDOWN REQUEST FORM INSTRUCTIONS

1. Starting on page 2, fill out all necessary information on the Utility Interruption/ Shutdown Request Form.
2. On page 3, fill out all necessary information on the Utility Interruption/ Shutdown Method of Procedure.
3. Utility Interruption/ Shutdown Request Forms can only be submitted to the Outage Coordinator by a University Representative. All others will be returned to sender.
4. Contractors submit your request to your University Project Manager, not the contracts listed below.
   a. Submit the Utility Interruption/ Shutdown Request Form and the Utility Interruption/ Shutdown Method of Procedure to:
   Jesse.Walklett@CUAnschutz.edu
   Cc…
   David.Tilton@CUAnschutz.edu
   Ron.Turner@CUAnschutz.edu
5. Requests for minor outages (determined by severity of impact) must be submitted to the Outage Coordinator seven (7) working days prior to the requested start date.
6. Requests for major outages (determined by severity of impact) must be submitted to the Outage Coordinator thirty (30) working days prior to the scheduled outage.
7. After receiving both the Utility Interruption/ Shutdown Request Form and the Utility Interruption/ Shutdown Method of Procedure, the Outage Coordinator will create an outage file and begin coordinating the request.
8. After the outage has been successfully coordinated, the request will be submitted for approval.
9. After the outage has been approved, the Outage Coordinator will send out the approved outage notice, create a meeting reminder for Facilities Staff, and send out the MOP followed by a Campus Announcement.

When an Outage is requested without the benefit of the minimum advance notice (7 days for a minor outage - 30 days for a major outage), **the Outage Coordinator will request that the Project Manager and Contractor still submit an adequate Method of Procedure (MOP) for the outage**. The requester will be responsible for distributing notices to the occupants of any and all affected area(s). The requester will also distribute a copy of the Outage Posting and a copy of the MOP to the Contractor and/or person performing the outage. The requester will then send, via email, the names of all the people they have distributed notices to, as confirmation to the Outage Coordinator.
ANY AND ALL DISPUTES WITH THE OCCUPANTS OF THE AFFECTED AREA(S) WILL BE RESOLVED BY THE REQUESTER.

In case of an EMERGENCY, contact the CSC at 303-724-1777

University of Colorado
Anschutz Medical Campus

Facilities Management

UTILITY INTERRUPTION/ SHUTDOWN REQUEST FORM

Utility or Service Requesting to be Interrupted or Shutdown	
Affected Areas (Building & Room Numbers)	
Outage Requester (Name & Phone Number)	
Requested Start Time & Start Date	**Time:** **Date:**
Anticipated Finish Time & Finish Date	**Time:** **Date:**
University Project Manager (Name & Phone Number)	
University Back-Up Project Manager (Name & Phone Number)	
Contractor (Name & Phone Number)	
Sub-Contractor (Name & Phone Number)	
Facilities Management Building Representative (Name & Phone Number)	
Maximo Work Order Number or Project Number	
Additional Assistance Required? (Check All Required) *Facilities Maintenance Use Only*	Zone Staff ___ Electrical Staff ___ Plumbing Staff ___ HVAC Staff ___ Shift Staff ___ Other___ (Who?) _____

Completely fill out the Method of Procedure section on page 3.

A missing or incomplete MOP will result in an automatic denial of the outage request.

University of Colorado
Anschutz Medical Campus

Facilities Management

UTILITY INTERRUPTION/ SHUTDOWN METHOD OF PROCEDURE

Clearly list all necessary actions in a step-by-step format that will be required for completion of this request.

Additional Notes:

SECTION 01 73 06

UTILITY INTERRUPTION – FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements governing the shutdown of fire protection systems for proper notification of all impacted by shutdown.

B. Contractor to complete attached outage request and submit to university project manager.

C. Outage requests must be submitted in advance per the time periods identified on attached form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 COORDINATION

A. University staff will coordinate and announce internally to all impacted areas.

B. Contractor & Subcontractors requesting outages must be present at specified time identified in approved outage request to initiate the start of outage. If contractors are not present, outage may be postponed.

C. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

END OF SECTION 01 73 06

University of Colorado Denver
Fire Protection System Impairment Request Form

(See instructions and additional information on pages 2 & 3)

All impairments, as a result of preplanned or emergency conditions, shall be inspected prior to generating the request to evaluate affected and unaffected areas. CU Project Manager, Fire & Life Safety, or BMO Rep. will submit this form.

IMPAIRMENT LOCATION/CONTACTS:

Project Location: _____

Permit# or PN#: _____ **(Mark "N/A" if work is done in house)**

Requestor-UCD PM or BMO Supervisor: _____

Email Address: _____ **Mobile #:** _____

Contractor: _____ **Office #:** _____

Jobsite Supervisor Name: _____ **Mobile #:** _____

Fire Alarm/Sprinkler Contractor: _____ **Mobile #:** _____

PRE-PLANNED IMPAIRMENT:

Date(s): _____ **to** _____ **Fire Protection System Test? Yes ( ) No ( )**

Time(s): _____ **to** _____ **Outside normal hours? Yes ( ) No ( )**

Fire Protection system devices to be added/deleted/moved? Yes ( ) No ( )

IMPAIRMENT DETAILS:

Device(s)/Component(s)/Function(s) to be impaired:

Reason for impairment (work being performed):

Method of fire alarm impairment(s): (To be completed by Fire & Life Safety prior to Approval)

Method of fire suppression impairment(s): (To be completed by Fire & Life Safety prior to Approval)

Fire watch to be employed? Yes ( ) No ( )

EMERGENCY IMPAIRMENT:

Describe emergency:

COMMENTS:

GENERAL INSTRUCTIONS

This form shall be used anytime a fire protection system (alarm or suppression), or portion thereof, is impaired as a result of pre-planned or emergency conditions, or if these systems could be impacted by dust or other adverse conditions related to construction activities. This form must be submitted and distributed by the responsible CU Project Manager (PM), CU BMO Supervisor, CU Fire & Life Safety, or other CU representative.

1. All pre-planned impairments to be done between the hours of 6:00 AM and 3:30 PM, Monday through Friday, unless requestor has made prior arrangements with the Fire and Life Safety Supervisor. (**Anschutz Campus**), Facilities Management. (**Denver Campus**).
2. Impairment requests for non-testing must be submitted by e-mail before 12:00 PM of the business day prior to the date of the requested impairment.
3. Impairment requests for testing must be submitted by e-mail before 12:00 PM two business days prior to the date of the requested impairment.
4. If there is a special hazard system in the area of the requested impairment (computer room, FM 200 System, etc.) it is the responsibility of the person requesting the impairment to have that system disabled by the owner of the system before starting work and enabling the system after completing work.
5. If system additions are made, ensure that devices are labeled accordingly with 8-digit addresses to ensure all field devices coincide with Fire Alarm Control Panel and Graphic Map.
6. **Noise related testing must be completed between 5:00am to 7:00am**.

SEND COMPLETED OUTAGE REQUEST FORMS TO APPROPRIATE FIRE & LIFE SAFETY (ANSCHUTZ), FACILITIES MANAGEMENT(DENVER) FOR APPROVAL

Anschutz Medical Campus
AMCFIRESYSTEMOUTAGE@UCDENVER.EDU

Denver Campus
DDCFIRESYSTEMOUTAGE@UCDENVER.EDU

ADDITIONAL INFORMATION

Steps for **FIRE ALARM / FIRE SPRINKLER** impairment:

1. **IMPAIRMENT LOCATION/CONTACTS:** Use placard information outside room and complete all contact information, input N/A if doesn't apply
2. **PRE-PLANNED IMPAIRMENT:** Refer to general instructions above for guidelines
3. **IMPAIRMENT DETAILS:** Locate devices in your area of work and input 8-digit address located on devices; provide details of work being performed. The rest will be completed by FLS.
4. **EMERGENCY IMPAIRMENT:** In the case of an emergency, FLS will assist with completing impairment. FLS is always available to assist immediately; you can find our information on page 3.

Steps for **FIRE ALARM** impairment throughout a project:

1. **Demo Impairment for Fire Alarm**: The intent of this impairment is for the fire alarm contractor to come in before the demo crew to safe off the existing system (existing wiring and devices). Then remove (de-program) smoke detection, pull stations, speakers, strobes, etc.… leave minimal notification coverage and install temporary heat detection at the deck if the sprinkler system is going to be drained.
2. **General Impairment for Fire Alarm**: The intent of this impairment is to support meetings, emergencies caused by construction activity, job walks to discuss existing, or additional support that cannot be provided by the GC.

3. **Tie-in / Program Impairment for Fire Alarm**: Project is almost complete; fire alarm contractor has passed the overhead inspection and the space has flooring and painting complete just working on final touches. Fire alarm contractor will come in and start connecting to the building system and program new devices. (This requires a lot of our time so we would prefer you narrow down the time as best as possible or provide details on the outage for your duration and in addition, give us a 12 – 24 hr. call before arrival so that we can adjust our schedules to support if the impairment is longer than a week.)
4. **Pre-Test / Final Impairment Fire Alarm**: These can be combined if the pre-test and final are within the same week otherwise we prefer separate impairments for each test.
    a. Typically combined with the fire sprinkler test.

Steps for **FIRE SPRINKLER** impairment throughout a project:

1. **Demo Impairment for Fire Sprinkler**: Upon completion of demo impairment for fire alarm and confirmation of temporary heat detection, the sprinkler contractor with support from our fluid group can drain down system.
2. **Re-Fill Impairment for Fire Sprinkler**: Project is almost complete; sprinkler contractor has passed the overhead inspection. Sprinkler contractor, with support from our fluid group, can then re-fill system.
3. **Pre-Test / Final Impairment Fire Sprinkler**: These can be combined if the pre-test and final are within the same week otherwise we prefer separate impairments for each test.
    a. Typically combined with the fire alarm test.

SYSTEM RESTORATION

Anschutz Medical Campus:
All fire protection system restorations shall be validated by the CU Fire & Life Safety for all affected impairments. Fire & Life Safety Supervisor and/or Campus Fire Marshall shall communicate applicable system restorations with local fire department and FM Global, as applicable to each impairment.

Denver Campus:
All fire protection system restorations shall be validated by Facilities Management and/or Code Official (possibly DFD) for all affected impairments and shall be communicated with local fire department and FM Global, as applicable to each impairment.

QUESTIONS AND CONTACTS

ANSCHUTZ MEDICAL CAMPUS FIRE & LIFE SAFETY:
Duxton Milam, Campus Fire Marshall: Mobile (720) 641-4490 Email: DUXTON.MILAM@CUANSCHUTZ.EDU
Brent Pool, Fire & Life Safety Supervisor: Mobile: (720) 951-4736 Email: BRENT.POOL@CUANSCHUTZ.EDU
Tyler Dunlap, Fire Alarm Technician: Mobile: (720) 717-0560 Email: TYLER.DUNLAP@CUANSCHUTZ.EDU
Mitch Brochu, Fire Alarm Technician: Mobile (720) 660-4431 Email: MITCHELL.BROCHU@CUANSCHUTZ.EDU
Eric Bevins, Fire Alarm Technician: Mobile (720) 951-7039 Email: ERIC.BEVINS@CUANSCHUTZ.EDU
Mark Beall, Fire Sprinkler Systems: Mobile: (720) 951-3364 Email: MARK.BEALL@CUANSCHUTZ.EDU

DOWNTOWN DENVER CAMPUS:
Keith Lemieux, Facilities Management: Mobile: (303) 591-6993 Email: BYRON.LEMIEUX@UCDENVER.EDU
Newman Forrester, Facilities Management: Mobile: (720) 641-7992 Email: NEWMAN.FORRESTER@UCDENVER.EDU

Updated: 10/01/19

SECTION 01 73 07

TEMPORARY FIRE DETECTION, SUPPRESSION, AND SITE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes administrative and procedural requirements governing the temporary fire detection and suppression requirements when impacting active construction activities in occupied facilities.

B. Contractor shall comply with all fire and life safety code requirements for projects that impact the existing detection and suppression systems.

C. All temporary protection requirements must be complete and active prior to the disabling or modifications to the existing systems.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 All detection and suppression requirements during construction must meet the 2018 International Fire Code (IFC) Section 33 and 3308.7, and 3301. All requirements as outlined in NFPA 241, Standard for Safeguarding Construction, Alterations, and Demolition Operations must also be followed.

3.2 STEPS for FIRE ALARM / FIRE SPRINKLER within project work:

A. Fire alarm and/or fire suppression systems protect all areas and need to be maintained throughout the entire duration of the project.

B. Smoke detection, heat detection, and fire suppression systems all rely on the ceiling structure as part of their functionality. All ceiling structures including ceiling tiles must be put back in place at the end of each workday to maintain functionality. A fire watch must be employed while any system impacts the functionality of suppression and detection systems. The use of a fire-retardant plastic covering at all openings is also acceptable.

C. If suppression, detection, and ancillary systems are impacted for longer than a fire watch can be employed, temporary heat detection will need to be install at the deck to maintain proper coverage and code requirements.

D. Fire detection and fire suppression systems can be taken offline to support project work; the FLS Impairment Form will need to be submitted through the CU project manager. Pages 2 and 3 of the Impairment form have instructions and additional information.

E. Fire detection and fire suppression contractors must always be the first to walk and address the project before demolition of any space begins. As mentioned, the ancillary systems including ceilings, are part of the protection systems and cannot be removed without temporary requirements being installed to maintain systems. Preferred methods are turning all sprinkler heads up towards the deck or installing heat detection at the deck before demolition.

F. Please note that fire suppression drain down require a re-fill at the end of each day unless fire watch or temporary heat detection is in place.

G. Contractors are expected to maintain all other code requirements as it pertains to fire and life safety.

END OF SECTION 01 73 07

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.
2. Section 31 10 00 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of minimum 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:

a. Asphalt paving.
b. Concrete.
c. Concrete reinforcing steel.
d. Brick.
e. Concrete masonry units.
f. Wood studs.
g. Wood joists.
h. Plywood and oriented strand board.
i. Wood paneling.
j. Wood trim.
k. Structural and miscellaneous steel.
l. Rough hardware.
m. Roofing.
n. Insulation.
o. Doors and frames.
p. Door hardware.
q. Windows.
r. Glazing.
s. Metal studs.
t. Gypsum board.
u. Acoustical tile and panels.
v. Carpet.
w. Carpet pad.
x. Demountable partitions.
y. Equipment.
z. Cabinets.
aa. Plumbing fixtures.
bb. Piping.
cc. Supports and hangers.
dd. Valves.
ee. Sprinklers.
ff. Mechanical equipment.
gg. Refrigerants.
hh. Electrical conduit.
ii. Copper wiring.
jj. Lighting fixtures.
kk. Lamps.
ll. Ballasts.
mm. Electrical devices.
nn. Switchgear and panelboards.
oo. Transformers.

2. Construction Waste:

a. Masonry and CMU.
b. Lumber.
c. Wood sheet materials.
d. Wood trim.
e. Metals.
f. Roofing.
g. Insulation.
h. Carpet and pad.
i. Gypsum board.
j. Piping.
k. Electrical conduit.
l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above,

salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Plastic pails.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 calendar days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste and Form CWM-8 for demolition waste, as applicable. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. LEED Submittal: LEED letter template for "Construction and Demolition Debris Management Planning" credit, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue

analysis. Where Project includes demolition, distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste, as applicable, generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use Form CWM-3 for construction waste and Form CWM-4 for demolition waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration

of the Contract.

1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Based on Project size and complexity, waste management coordinator may, if approved in writing by Architect/Engineer and University Project Manager, serve in other construction related roles.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three business days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted on Project site.

C. Salvaged Items for University's Use: Salvage items for University's use and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to University.
4. Transport items to University's storage area designated by University.
5. Protect items from damage during transport and storage.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

F. Plumbing Fixtures: Separate by type and size.

G. Lighting Fixtures: Separate lamps by type and protect from breakage.

H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

    a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from University's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum 1-1/2-inch size.

1. Crush asphaltic concrete paving and screen to comply with requirements in Section 31 20 00 "Earth Moving" for use as general fill.

B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum 1-1/2-inch size.
2. Crush concrete and screen to comply with requirements in Section 31 20 00 "Earth Moving" for use as satisfactory soil for fill or subbase.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Pulverize masonry to maximum 3/4-inch size.

    a. Crush masonry and screen to comply with requirements in Section 31 20 00 "Earth Moving" for use as satisfactory soil for fill or subbase.

b. Crush masonry and screen to comply with requirements in Section 32 93 00 "Plants" for use as mineral mulch.

2. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

F. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

J. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

K. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

L. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

M. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

N. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: If gypsum board is processed on site, grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding. At Contractor's option, processing may occur off site.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from University's property and legally dispose of them.

3.7 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

C. Form CWM-3 for construction waste reduction work plan.

D. Form CWM-4 for demolition waste reduction work plan.

E. Form CWM-7 for construction waste reduction progress report.

F. Form CWM-8 for demolition waste reduction progress report.

END OF SECTION 01 74 19

FORM CWM-1: CONSTRUCTION WASTE IDENTIFICATION							
MATERIAL CATEGORY	**GENERATION POINT**	**EST. QUANTITY OF MATERIALS RECEIVED* (A)**	**EST. WASTE - % (B)**	**TOTAL EST. QUANTITY OF WASTE* (C = A x B)**	**EST. VOLUME CY (CM)**	**EST. WEIGHT TONS (TONNES)**	**REMARKS AND ASSUMPTIONS**
Packaging: Cardboard							
Packaging: Boxes							
Packaging: Plastic Sheet or Film							
Packaging: Polystyrene							
Packaging: Pallets or Skids							
Packaging: Crates							
Packaging: Paint Cans							
Packaging: Plastic Pails							
Site-Clearing Waste							
Masonry or CMU							
Lumber: Cut-Offs							
Lumber: Warped Pieces							
Plywood or OSB (scraps)							
Wood Forms							
Wood Waste Chutes							
Wood Trim (cut-offs)							
Metals							
Insulation							
Roofing							
Joint Sealant Tubes							
Gypsum Board (scraps)							
Carpet and Pad (scraps)							
Piping							
Electrical Conduit							
Other:							

* Insert units of measure.

FORM CWM-2: DEMOLITION WASTE IDENTIFICATION				
MATERIAL DESCRIPTION	**EST. QUANTITY**	**EST. VOLUME CY (CM)**	**EST. WEIGHT TONS (TONNES)**	**REMARKS AND ASSUMPTIONS**
Asphaltic Concrete Paving				
Concrete				
Brick				
CMU				
Lumber				
Plywood and OSB				
Wood Paneling				
Wood Trim				
Miscellaneous Metals				
Structural Steel				
Rough Hardware				
Insulation				
Roofing				
Doors and Frames				
Door Hardware				
Windows				
Glazing				
Acoustical Tile				
Carpet				
Carpet Pad				
Demountable Partitions				
Equipment				
Cabinets				
Plumbing Fixtures				
Piping				
Piping Supports and Hangers				
Valves				
Sprinklers				
Mechanical Equipment				
Electrical Conduit				
Copper Wiring				
Light Fixtures				
Lamps				
Lighting Ballasts				
Electrical Devices				
Switchgear and Panelboards				
Transformers				
Other:				

FORM CWM-3: CONSTRUCTION WASTE REDUCTION WORK PLAN						
MATERIAL CATEGORY	GENERATION POINT	TOTAL EST. QUANTITY OF WASTE TONS (TONNES)	DISPOSAL METHOD AND QUANTITY			HANDLING AND TRANSPORTION PROCEDURES
			EST. AMOUNT SALVAGED TONS (TONNES)	EST. AMOUNT RECYCLED TONS (TONNES)	EST. AMOUNT DISPOSED TO LANDFILL TONS (TONNES)	
Packaging: Cardboard						
Packaging: Boxes						
Packaging: Plastic Sheet or Film						
Packaging: Polystyrene						
Packaging: Pallets or Skids						
Packaging: Crates						
Packaging: Paint Cans						
Packaging: Plastic Pails						
Site-Clearing Waste						
Masonry or CMU						
Lumber: Cut-Offs						
Lumber: Warped Pieces						
Plywood or OSB (scraps)						
Wood Forms						
Wood Waste Chutes						
Wood Trim (cut-offs)						
Metals						
Insulation						
Roofing						
Joint Sealant Tubes						
Gypsum Board (scraps)						
Carpet and Pad (scraps)						
Piping						
Electrical Conduit						
Other:						

FORM CWM-4: DEMOLITION WASTE REDUCTION WORK PLAN						
MATERIAL CATEGORY	GENERATION POINT	TOTAL EST. QUANTITY OF WASTE TONS (TONNES)	DISPOSAL METHOD AND QUANTITY			HANDLING AND TRANSPORTION PROCEDURES
			EST. AMOUNT SALVAGED TONS (TONNES)	EST. AMOUNT RECYCLED TONS (TONNES)	EST. AMOUNT DISPOSED TO LANDFILL TONS (TONNES)	
Asphaltic Concrete Paving						
Concrete						
Brick						
CMU						
Lumber						
Plywood and OSB						
Wood Paneling						
Wood Trim						
Miscellaneous Metals						
Structural Steel						
Rough Hardware						
Insulation						
Roofing						
Doors and Frames						
Door Hardware						
Windows						
Glazing						
Acoustical Tile						
Carpet						
Carpet Pad						
Demountable Partitions						
Equipment						
Cabinets						
Plumbing Fixtures						
Piping						
Supports and Hangers						
Valves						
Sprinklers						
Mechanical Equipment						
Electrical Conduit						
Copper Wiring						
Light Fixtures						
Lamps						
Lighting Ballasts						
Electrical Devices						
Switchgear and Panelboards						
Transformers						
Other:						

FORM CWM-7: CONSTRUCTION WASTE REDUCTION PROGRESS REPORT								
MATERIAL CATEGORY	GENERATION POINT	TOTAL QUANTITY OF WASTE TONS (TONNES) (A)	QUANTITY OF WASTE SALVAGED		QUANTITY OF WASTE RECYCLED		TOTAL QUANTITY OF WASTE RECOVERED TONS (TONNES) (D = B + C)	TOTAL QUANTITY OF WASTE RECOVERED % (D / A x 100)
			ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (B)	ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (C)		
Packaging: Cardboard								
Packaging: Boxes								
Packaging: Plastic Sheet or Film								
Packaging: Polystyrene								
Packaging: Pallets or Skids								
Packaging: Crates								
Packaging: Paint Cans								
Packaging: Plastic Pails								
Site-Clearing Waste								
Masonry or CMU								
Lumber: Cut-Offs								
Lumber: Warped Pieces								
Plywood or OSB (scraps)								
Wood Forms								
Wood Waste Chutes								
Wood Trim (cut-offs)								
Metals								
Insulation								
Roofing								
Joint Sealant Tubes								
Gypsum Board (scraps)								
Carpet and Pad (scraps)								
Piping								
Electrical Conduit								
Other:								

FORM CWM-8: DEMOLITION WASTE REDUCTION PROGRESS REPORT								
MATERIAL CATEGORY	GENERATION POINT	TOTAL QUANTITY OF WASTE TONS (TONNES) (A)	QUANTITY OF WASTE SALVAGED		QUANTITY OF WASTE RECYCLED		TOTAL QUANTITY OF WASTE RECOVERED TONS (TONNES) (D = B + C)	TOTAL QUANTITY OF WASTE RECOVERED % (D / A x 100)
			ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (B)	ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (C)		
Asphaltic Concrete Paving								
Concrete								
Brick								
CMU								
Lumber								
Plywood and OSB								
Wood Paneling								
Wood Trim								
Miscellaneous Metals								
Structural Steel								
Rough Hardware								
Insulation								
Roofing								
Doors and Frames								
Door Hardware								
Windows								
Glazing								
Acoustical Tile								
Carpet								
Carpet Pad								
Demountable Partitions								
Equipment								
Cabinets								
Plumbing Fixtures								
Piping								
Supports and Hangers								
Valves								
Sprinklers								
Mechanical Equipment								
Electrical Conduit								
Copper Wiring								
Light Fixtures								
Lamps								
Lighting Ballasts								
Electrical Devices								
Switchgear and Panelboards								
Transformers								
Other:								

SECTION 01 77 00 CLOSEOUT PROCEDURES

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures, including Notice of Completion and Final Inspection procedures.
2. Occupancy procedures, including Notice of Approval of Occupancy/Use and University Supplemental Notice of Occupancy and Use List.
3. Final Acceptance procedures, including Pre-Acceptance Checklist and University Supplemental Building/Project Acceptance List.
4. Inspections after completion.
5. Warranties.
6. Final cleaning.
7. Repair of the Work.

B. Related Requirements:

1. Section 01 32 33 "Photographic Documentation" for submitting final completion construction photographic documentation.
2. Section 01 73 00 "Execution" for progress cleaning of Project site.
3. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
5. Section 01 79 00 "Demonstration and Training" for requirements for instructing University's personnel.

1.3 ACTION SUBMITTALS

A. Product Data: For cleaning agents.

B. Contractor's List of Incomplete Items: Initial submittal at Notice of Completion.

C. Certified List of Incomplete Items: Final submittal at Final Acceptance.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 NOTICE OF COMPLETION AND SUBSTANTIAL COMPLETION PROCEDURES

A. Procedures and Submittals Prior to Notice of Completion: Complete and submit all of the following items prior to submitting Notice of Completion to Architect/Engineer. Include Contractor's comprehensive list of items to be completed, corrected or not in compliance with the Drawings and Specifications.

1. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's preliminary punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
2. Building Inspection Record: Submit completed record with all required corrections noted.
3. Certificate of Occupancy: Submit Certificate of Occupancy (CO) or Temporary Certificate of Occupancy (TCO).
4. Final Completion Schedule: Submit schedule for performing and completing all work indicated on the Contractor' list of incomplete items.
5. Submit sustainable design documentation.
6. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
7. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
8. Submit test/adjust/balance records.

B. Final Inspection: Submit Notice of Completion to Architect/Engineer. Upon receipt, Architect/Engineer and University will review and if all items on the University Supplemental Notice of Completion Checklist are complete will, within the timeframe required by the Contract, schedule and make an inspection of the Project to determine whether the Work is substantially complete.

1. Final Punch List: Based on the inspection, Architect/Engineer will prepare a final punch list of work to be completed, work not in compliance with the Drawings or Specifications, and unsatisfactory work for any reason.
2. Re-inspection: If the cumulative number of items identified on the final punch list prevents a determination that the work is substantially complete, complete those items and when complete resubmit Notice of Completion. Upon receipt of resubmittal, Architect/Engineer and University will then schedule and make a re-inspection of the Project to determine whether the Work is substantially complete.

C. Notice of Substantial Completion: When inspection of the Work indicates that the Project is substantially complete and all other Contract provisions required for substantial completion have been satisfied, Architect/Engineer will issue a Notice of Substantial Completion (State Form SBP-07).

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor or as approved by Architect/Engineer.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect/Engineer.
    d. Name of Contractor.
    e. Page number.

4. Submit list of incomplete items in the following format:

    a. MS Excel and PDF electronic file. Architect/Engineer will return annotated file.

1.8 OCCUPANCY PROCEDURES

A. Procedures and Submittals Prior to Occupancy: Complete and submit all items on both State Form SBP-01 “Notice of Approval of Occupancy/Use” and University Supplemental Notice of Occupancy and Use List.

1.9 FINAL ACCEPTANCE PROCEDURES

A. Procedures and Submittals Prior to Final Acceptance: Complete and submit all items on both State Form SBP-05 “Pre-Acceptance Checklist” and University Supplemental Building/Project Acceptance List.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 business days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.10 SETTLEMENT AND FINAL PAYMENT

A. Submit and complete all of the following as a condition precedent to settlement and final payment:

1. All guarantees and warranties.
2. All statement to support local sales tax refunds, if any.
3. Three (3) sets of operation and maintenance manuals.
4. One (1) set of as-built Contract Documents showing all job changes.
5. All demonstration and training completed in accordance with Section 01 79 00.

6. All punch list items documented as complete.

B. Final Certificate of Payment: Submit in accordance with the requirements of Section 01 29 00 “Payment Procedures.”

1.11 INSPECTIONS AFTER COMPLETION

A. Warranty/Guarantee Inspections: During the warranty period, accompany Architect/Engineer and University Representative, and participate in inspection(s) of the Project to identify defective and deficient work at intervals and as required by the Contract.

B. List of Deficient or Defective Work: Within 10 business days of inspection, Architect/Engineer will provide Contractor with a list of items requiring correction.

C. Remedial Work: Upon receive of itemized list, immediately correct and remedy deficiencies and defects in a manner satisfactory to the Architect/Engineer and University.

1.12 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties to the Architect/Engineer prior to advertisement of the Notice of Contractor's Settlement. If the Notice of Acceptance designates a commencement date for warranties other than the date of Notice of Acceptance for the Work, or a designated portion of the Work, submit written warranties upon request of the Architect.

B. Partial Occupancy: When a designated portion of the Work is completed and occupied or used by the University, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Architect/Engineer within fifteen (15) calendar days of completion of that designated portion of the Work.

C. Special Warranties: When a special warranty is required to be executed by the Contractor, or the Contractor and a Subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the University through the Architect/Engineer for approval prior to final execution. Refer to individual Specification Sections for specific requirements for special warranties.

D. Form of Submittal: Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

1. Number of Copies: Two.
2. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
3. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
4. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
5. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

E. Provide additional copies of each warranty to include in operation and maintenance manuals.

F. List of Extended Warranties: Provide a comprehensive list of all manufacturers' standard and special warranties with duration greater than one year after Notice of Acceptance. Organize list into an orderly sequence based on table of contents of the Project Manual.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.
2. Do not use sweeping compounds on concrete floors that will leave residue affecting finish floor materials.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations immediately prior to Occupancy for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior finishes to a dirt-free condition, free of grease, dust, stains, films, fingerprints, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
j. Power scrub and power buff resilient flooring surfaces, tile and fluid-applied flooring.
k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

l. Remove labels that are not permanent.
m. Wipe surfaces of mechanical and electrical equipment, elevator equipment where applicable, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.

1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.

q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
r. Clean food service equipment to sanitary condition acceptable for intended food service use and approved by authority having jurisdiction.
s. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

3.3 ATTACHMENTS

A. Samples of the following forms are appended to this Section for reference following End of Section 01 77 00:

1. University of Colorado Denver | Anschutz Medical Campus Supplemental Notice of Occupancy and Use List.

2. University of Colorado Denver | Anschutz Medical Campus Supplemental Building / Project Acceptance List.

END OF SECTION 01 77 00

University of Colorado
Denver | Anschutz Medical Campus

Supplemental Notice of Occupancy and Use List

Project Name & Number: _____

Contractor: _____

In addition to completing Notice of Approval of Occupancy / Use (SBP-01), the following items must be completed before Occupancy is approved.

Activity	Date Completed	Remarks
1. Final and formal address posted on the building entries.		
2. A copy of the Contractor's in-progress red line "as-built" drawings has been given to BMO representative & a 2nd copy is provided for Projects plan room. This is to include landscape drawings showing irrigation installation.		
3. Maintenance, operations and spare parts manuals on all installed equipment.		
4. Notice of Partial Substantial Completion concerning roles/ responsibilities of University and Contractor for security, maintenance, heat, utilities reviewed and accepted.		
5. Manufacturer maintenance, operations and spare parts manuals for fixtures, mechanical, electrical and plumbing.		
6. Hardware maintenance, operations and spare parts manuals for doors & locks, including roll up doors.		
7. Warranty Dates and Contact list for all Contractors and Suppliers given to BMO.		
8. Transfer utility account from Contractor to Facilities Operations.		
9. Site plan to include first floor main isolation locations and plans for each floor to include main utility shutoffs, for utilities to include water, electrical, steam, sewer, fuel supply, telecom, fiber optic and gasses, identified on a set of drawings.		
10. If Commissioning Report is completed, BMO has reviewed/ commented, including electrical, plumbing, mechanical/ HVAC.		
11. All Contractor provided equipment has new filters & construction filters removed.		
12. Not Used		
13. Elevator equipment rooms insulated and space conditioned for control system requirements.		
14. Testing Certifications provided to BMO for Elevators, Fire Systems & Annunciator Systems.		
15. FSS has been provided with copy of Building Department testing and inspection report for window washing equipment.		
16. Roof walking pads to access equipment are installed.		
17. PM to communicate to fire department via Life Safety Officer that building has transitioned to BMO. Alarms at Anschutz Medical Campus report to University Police Dispatch and at Downtown report to designated monitoring company.		

18. BAS System (Siemens), Energy and Lighting, Fuel Systems, and Power Management must report remotely & verify with University - Engineering.		
19. Training for BMO and FSS on installed equipment and systems is completed.		
20. Equipment keys and locks transitioned to Operations, including fire panels, electrical panels, directories and generator panels. Construction cores removed and replaced with permanent cores.		
21. Access control pathways and junction boxes for installed doors, gates, loading docks and roof access complete. ***All wiring and hardware completed and electronic security access controls in place and tested by University Electronic Security.**		
22. EH&S is provided, as applicable for project, with fume hood certification, water testing certification, hazardous waste compliance certification, radiation compliance certification, BSL3 certification, and all other specialty equipment certification.		
23. PM notifies University Risk Management that project is transferring to University and notifies Contractor that it can eliminate Builders Risk Insurance.		
24. Not Used		
25. Not Used		
26. Elevator tools, including hand tools, computer, proprietary and operational software is received and confirm 1-year service from date of acceptance.		
27. All computers and software required in drawings and specs. are received, including for BAS, Energy and Lighting, Fuel Systems, and Power Management, and any specialty software and alarm codes for operating systems.		
28. For all areas to be transferred to University, all waste and debris removed; floor and wall surfaces clean and in good repair; ceiling surfaces clean, unmarked, in place; site, including sidewalks, cleared of debris and construction equipment; and roof is clear of all materials and debris.		
29. Water chlorination and testing complete and provided by PM to Chief Building Official and BMO via BMO Rep.		
30. Toilet accessories are in place that meet custodial contract.		
31. Trash receptacles outside the building are in place		

University Project Manager (sign & print name) Date

University BMO Rep. (sign & print name) Date

University FSS Rep (sign & print name) Date

University Downtown Rep. (If Necessary) (sign & print name) Date

***Highlighted items are not the responsibility of Contractor but PM and BMO Rep must ensure these are completed and operational prior to occupancy and use.**

Mark N/A by item if it is not applicable to project

3.1.12

University of Colorado
Denver | Anschutz Medical Campus

Supplemental Notice of Occupancy and Use List - Building / Project Acceptance List

Project Name & Number: _____

Contractor: _____

In addition to completing Notice of Approval of Occupancy / Use (SBP-01), the following items must be completed before Occupancy is approved.

Activity	Date Completed	Remarks
1. Review State Buildings Pre-Acceptance check list & Notice of Approval of Occupancy / use form with BMO rep & confirm agreement with status		
2. Training for BMO and FSS on installed equipment and systems is completed.		
3. Final and formal address posted on the building entries. Signage in place including monument sign, site signage, exterior and interior signage		
4. Roof walking pads to access equipment are installed.		
5. Plan to include first floor main isolation locations and plans for each floor to include main utility shutoffs, for include water, electrical, steam, sewer, fuel supply, telecom, fiber optic and gasses.		
6. All Contractor provided equipment has new filters & construction filters removed. Attic stock is inventoried, located in secured location, and matches spec. requirements.		
7. Maintenance & operations manuals and spare parts provided to BMO Representative and BMO Archivist; Including at least: fixtures, mechanical, electrical, plumbing, hardware for doors & locks, roll up doors, Spare fire suppression heads, tool & spare fuses		
8. Testing Certifications provided to BMO for Fire Systems & Annunciator Systems. Cabinet in main electrical room includes one complete set for major equipment. Alarms at Anschutz Medical Campus report to University Police Dispatch and at Downtown report to designated monitoring company.		
9. Equipment keys and locks transitioned to Operations, including fire panels, electrical panels, directories and generator panels. Construction cores removed and replaced with permanent cores.		
10. Access control pathways and junction boxes for installed doors, gates, loading docks and roof access complete. ***All wiring and hardware completed and electronic security access controls in place and tested by University Electronic Security.**		
11. BAS System (Siemens), Energy and Lighting, Fuel Systems, and Power Management must report remotely. Verify with University Engineering. All computers and software required in drawings and specs are received, including for BAS, Energy and Lighting, Fuel Systems, and Power Management, and any specialty software and alarm codes for operating systems.		
12. Notice of Partial Substantial Completion concerning roles/ responsibilities of University and Contractor for security, maintenance, heat, utilities has been reviewed and accepted. Establish list of post construction change orders & track separately from basic project until items are complete – call it Phase 2 to avoid delay on basic project.		

13. Warranty Dates and Contact list for all Contractors and Suppliers given to BMO.		
14. EH&S is provided, as applicable: fume hood certification, water testing certification, hazardous waste compliance certification, radiation compliance certification, BSL3 certification, and all other specialty equipment certification.		
15. All required Regulatory reports, have been provided to BMO, including: Air Emissions; Sewer, including for process diverters, traps, collection tanks, Fuel Storage Tanks and Detection, and Water System tests.		
16. A copy of the Contractor's red line "as-builts" and signed stamped drawings for Fire Detection and Suppression has been given to AE, BMO rep and placed in the Projects plan room. AE will prepare Record Documents. A hard copy of Record Documents will replace the redlines once available in the plan room. Hard copy or electronic copy will be provided to BMO. Electronic copies only will be provided to the Archive Officer. .		
17. Electrical system one line diagram framed and mounted in electrical room.		
18. **Move-related work items complete including physical move, tours (occupants & police), mail, phone & electrical hook ups for equipment & furniture systems complete & freezers enrolled in University freezer program.**		
19. Interior Finishes Binder given to the University Project Manager and an electronic copy given to the Archive Officer.		
20. If Commissioning Report is completed, BMO has reviewed/ commented, including electrical, plumbing, mechanical/ HVAC.		
21. Testing Certifications provided to BMO for Elevators. Elevator tools, including hand tools, computer, proprietary and operational software is received and confirm 1-year service from date of acceptance. Elevator equipment rooms insulated and space conditioned for control system requirements.		
22. FSS has been provided with copy of Building Department testing and inspection report for window washing equipment.		
23. PM notifies University Risk Management that project is transferring to University and notifies Contractor that it can eliminate Builders Risk Insurance. PM to communicate to fire department via Life Safety Officer that building has transitioned to BMO.		
24. Trash receptacles outside the building are in place. If exterior work is applicable: Landscape – Include a walk through with University Grounds for 1) new & established 1-year service date; 2) existing damaged landscape is repaired; and 3) irrigation – zone control test is complete.		
25. Other: TAB Reports for Water and Air.		

University Project Manager (sign & print name) Date

University BMO Rep. (sign & print name) Date

University FSS Rep (sign & print name) Date

***Highlighted items are not the responsibility of Contractor but PM and BMO Rep must ensure these are completed and operational prior to occupancy and use.**

Mark N/A by item if it is not applicable to project

University of Colorado
Denver | Anschutz Medical Campus

Supplemental Building / Project Acceptance List

Project Name & Number: _____

Contractor: _____

In addition to completing Pre-Acceptance Checklist (SBP-05), the following items must be completed before Final Acceptance.

Activity	Date Completed	Remarks
1. Review State Buildings Pre-Acceptance check list & Notice of Approval of Occupancy / use form with BMO rep & confirm agreement with status		
*2. Establish list of post construction change orders & track separately from basic project until items are complete – call it Phase 2 to avoid delay on basic project		
3. O & M Manuals given to BMO Representative and BMO Archivist (2 hard copies and 1 electronic total)		
*4. Record Documents – a hard copy of plans and specifications are provided for plan room & given to BMO & electronic auto cad & specs are given to Archive Officer (Art Steinman) this is to include landscape drawings showing irrigation installation. Fire Alarm and suppression system shall have record drawings produced by the contractor and shall include PDFs and native graphic files, and CAD files include graphics maps and Fireworks graphics.		
*5. Final Site Walk is completed with University Grounds Supervisor. Drain barriers are removed and storm drains cleared. MS4 storm water plan, CDPHE permits, and evidence of final closeout received by Project Manager and all copied to University Engineering Division.		
*/**6. **Move-related work items complete including physical move, tours (occupants & police), mail, phone & electrical hook ups for equipment & furniture systems complete & freezers enrolled in University freezer program.**		
7. If exterior work is applicable: Landscape – Include a walk through with University Grounds for 1) new & established 1-year service date; 2) existing damaged landscape is repaired; and 3) irrigation – zone control test is complete.		
8. Attic stock, matches spec. requirements, is located in secured location, and is inventoried.		
9. Electrical system one line diagram framed and mounted in electrical room.		
10. Spare fire suppression heads in cabinets and tool: cabinet in main electrical room includes one complete set of spare fuses for major equipment.		
11. Contractor keys issued by University BMO returned to University Key Shop via PM/ BMO Rep.		
12. Interior Finishes Binder given to the University Project Manager: (Two hard copies)		

13. Not Used		
14. Not Used		
15. Safety grating in pipe chases in place.		
16. Signs in place including monument sign, building exterior and site signage and building interior signage.		
17. All applicable reports, including Air Emission reports; Sewer Reports, including for process diverters, traps and collection tanks; Fuel Storage Tank and Detection reports; and Water System tests and reports provided to BMO via PM and BMO Rep.		
18. Not Used		
19. Not Used		
20. Not Used		
21. Not Used		
22. If commissioning is included for project, Commissioning Agent certification is received by BMO via PM and BMO Rep.		

University Project Manager (sign & print name) Date

University BMO Rep. (sign & print name) Date

University FSS (sign & print name) Date

University Downtown Rep (if necessary) (sign & print name) Date

*Warranty dates are not subject to completion of these items by contract

**** Highlighted items are not the responsibility of Contractor but PM and BMO Rep must ensure these are completed and operational prior to occupancy and use.**

Mark N/A by item if it is not applicable to project

3.1.12

SECTION 01 78 23 OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Systems, subsystems, and equipment operation and maintenance manuals.
3. Product maintenance manuals.
4. Emergency manuals.
5. Framed operating and maintenance instructions.

B. Related Requirements:

1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Section 01 91 13 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Schedule: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 30 calendar days before commencing demonstration and training. Architect/Engineer will return copy with comments.

1. Correct or revise each manual to comply with Architect/Engineer's comments. Submit copies of each corrected manual within 15 calendar days of receipt of Architect/Engineer's comments and prior to commencing demonstration and training.

B. Format: Submit operations and maintenance manuals in the following format:
1. Paper copies. Assemble in accordance with the requirements of this Section.

a. Submit three final copies, one to be retained by the Architect/Engineer and two to be retained by the University.

C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 30 calendar days before commencing demonstration and training. Architect/Engineer will return copy with comments.

1. Correct or revise each manual to comply with Architect/Engineer's comments. Submit copies of each corrected manual within 15 calendar days of receipt of Architect/Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Intent: Prepare data in form of an instructional manual for use by University personnel.

B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

C. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of University.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect/Engineer.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Architect/Engineer that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

F. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

G. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

H. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in minimum 1 inch and maximum 2 inch thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch, 20 lb., white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 SYSTEMS, SUBSYSTEMS AND EQUIPMENT OPERATION AND MAINTENANCE MANUALS

A. General: Provide operation and maintenance manuals where indicated in individual Specification Section and the following:

1. Heating, ventilating and air-conditioning equipment and systems.
2. Plumbing equipment and systems.
3. Special piping equipment and systems.
4. Electrical distribution systems.
5. Standby generator systems.
6. Communications systems.
7. Fire alarm and detection systems.
8. Underground sprinkler systems.
9. Automatic entrances.
10. Food service equipment.
11. Elevators.
12. Other special construction and conveying systems.

B. Operation Content: In addition to requirements in this Section, include operation data required in individual Specification Sections.

1. Additional Operation Content Required:

   a. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
   b. Performance and design criteria if Contractor has delegated design responsibility.
   c. Operating standards.
   d. Operating procedures.
   e. Operating logs.
   f. Wiring diagrams.
   g. Control diagrams.
   h. Piped system diagrams.
   i. Precautions against improper use.
   j. License requirements including inspection and renewal dates.

2. Descriptions: Include the following:

   a. Product name and model number. Use designations for products indicated on Contract Documents.
   b. Manufacturer's name.
   c. Equipment identification with serial number of each component.
   d. Equipment function.
   e. Operating characteristics.
   f. Limiting conditions.
   g. Performance curves.
   h. Engineering data and tests.
   i. Complete nomenclature and number of replacement parts.

3. Operating Procedures: Include the following, as applicable:

   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Instructions on stopping.
   f. Normal shutdown instructions.
   g. Seasonal and weekend operating instructions.
   h. Required sequences for electric or electronic systems.
   i. Special operating instructions and procedures.

4. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
5. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

C. Maintenance Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

1. Source Information: Provide the following information in a list for each product included in manual:

   a. Name, address, and telephone number of Installer or supplier and maintenance service agent.

b. Name, address, and telephone number of local source for supply of replacement parts.
c. Name, address, and telephone number of maintenance contractor, where appropriate.
d. Cross-reference Specification Section number and title.
e. Drawing or schedule designation or identifier where applicable.

2. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

a. Standard maintenance instructions and bulletins.
b. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
c. Identification and nomenclature of parts and components.
d. List of items recommended to be stocked as spare parts.

3. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

a. Test and inspection instructions.
b. Troubleshooting guide.
c. Precautions against improper maintenance.
d. Disassembly; component removal, repair, and replacement; and reassembly instructions.
e. Aligning, adjusting, and checking instructions.
f. Demonstration and training video recording, if available.

4. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

a. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
b. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

5. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
6. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
7. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

a. Include procedures to follow and required notifications for warranty claims.
b. Include information sheet covering proper procedures in event of failure and instances which might affect validity of warranties and bonds.

2.3 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Separate into two manuals: one for exterior moisture protection products and those exposed to weather and one for interior products. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: Provide the following information for each product included in manual:

1. Name, address, and telephone number of Installer or supplier and maintenance service agent.
2. Cross-reference Specification Section number and title.
3. Drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.4 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of University's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.

4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.5 FRAMED OPERATING AND MAINENANCE INSTRUCTIONS

A. All mechanically and electrically operated equipment and controls shall be provided with legible and complete wiring diagrams, schematics, operating instructions, and pertinent preventative maintenance instructions in a sturdy frame with clear glass or plastic cover. Use non-fading, permanent media.

B. Locate frames in the same room or service enclosure as equipment, or in the nearest mechanical or electrical room.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 23

SECTION 01 78 39 PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Record Samples.
5. Miscellaneous record submittals.

B. Related Requirements:

1. Section 01 73 00 "Execution" for final property survey.
2. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
3. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. General: Submit record drawings with duplicate original transmittal letters containing:

1. Date.
2. Project title and number.
3. Contractor’s name and address.
4. Certification that each document as submitted is complete and accurate.
5. Signature of authorized representative of the Contractor.

B. Record Drawings: Submit copies of record Drawings as follows:

1. Submit three paper-copy sets of marked-up record prints, two copies will be retained by the University and one copy retained by the Architect/Engineer.
2. Submit three paper-copy sets and three digital copies on CD of electronic files for all delegated-design submittals. Two copies will be retained by the University and one copy retained by the Architect/Engineer.

C. Record Specifications: Submit three paper copies **of** Project's Specifications, including addenda and contract modifications. Two copies will be retained by the University and one copy retained by the Architect/Engineer.

D. Record Product Data: Submit three paper copies of each submittal. Two copies will be retained by the University and one copy retained by the Architect/Engineer.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

E. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit three paper copies of each submittal. Two copies will be retained by the University and one copy retained by the Architect/Engineer.

F. Interior Finishes Binder: Three copies. Two copies will be retained by the University and one copy retained by the Architect/Engineer.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.
f. Mark using line types and symbols conforming to Contract Documents.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations below first floor.
d. Locations and depths of underground utilities referenced to permanent surface improvements.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities referenced to visible and accessible features of structure.
j. Locations of concealed valves, dampers, controls, balancing devices, junction boxes, cleanouts, and other items requiring access or maintenance.
k. Changes made by Change Order.
l. Changes made following Architect/Engineer's written orders.
m. Details not on the original Contract Drawings.
n. Field records for variable and concealed conditions.

o. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark additional information important to University that was either shown schematically or omitted from original Drawings.
6. Note Change Order numbers, and similar identification, where applicable.

B. Record Delegated Design Electronic Files: For all delegated design submittals, including but not limited to landscape irrigation, fire alarm and fire sprinkler plans, prepare electronic files in full compliance with University of Colorado Denver | Anschutz Medical Campus Guidelines and Design Standards, Part 1.0, Paragraph “Drawing Production Standards.”

C. Identification: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Architect/Engineer.
e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to substitutions, selection of options, and similar information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Note related Change Orders where applicable.
4. Maintain one complete copy of all Addenda, Change Orders and other written change documents in printed form during construction.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Directory: Include record Product Data directory organized by Specification Section number and title.

C. Product List: Update and record any changes to Product List submitted in accordance with Section 01 60 00 "Product Requirements", including any changes to brand, model, subcontractor, or Installer so that final list reflects materials, equipment and systems incorporated into the Work.

2.4 RECORD SAMPLES

A. Prior to Final Acceptance, meet with University Project Manager and Architect/Engineer at site to review and identify which submitted samples maintained during the progress of the Work are to be transmitted to the University.

B. Deliver selected samples to storage area identified by University.

C. Finishes Binder: Three-ring notebook or notebooks, organized by Specification Section number, providing a listing and description of all material finishes on the Project and including a minimum 6 inch by 6 inch sample thereof to accompany the description. Accompany each material selection indicated with the following:

1. Manufacturer and product name.
2. Pattern name and number, as applicable.
3. Color name, as applicable.
4. Any additional information required to order replacement product.

2.5 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1. Include manufacturer's certifications, field test record, copies of permits, licenses, certifications, inspection reports, releases, notices, receipts for fee payments and similar documents.

B. Directory: Include miscellaneous record submittals directory organized by Specification Section number and title.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project. Update at least weekly.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect/Engineer's and University's reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 78 46 EXTRA STOCK MATERIALS

PART 1 - GENERAL

1.1 RELATED DOCUMETS

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

1.2 SUMMARY

A. Section includes descriptions and quantities of required extra stock materials.

1.3 INFORMATIONAL SUBMITTALS

A. Schedule of Maintenance Materials: Prepare a schedule in tabular form of all extra stock materials required in individual Specification Sections including:

1. Specification Section number and title.
2. Description of required material
3. Quantity of required material.

1.4 MAINTENANCE MATERIALS

A. Furnish extra materials that match and are from the same production runs as the product installed.

B. Provide in the quantities indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 MAINTENANCE MATERIAL SCHEDULE

SECTION	TITLE	DESCRIPTION	QUANTITY

09 30 00	TILING	Tile and Trim Units	Furnish 100 sq. ft. of full-size units for each type, composition, color, pattern, and size indicated.
09 51 13	ACOUSTICAL PANEL CEILINGS	Acoustical Ceiling Panels	100 sq. ft. of full-size panels.
09 51 23	ACOUSTICAL TILE CEILINGS	Acoustical Ceiling Units	100 sq. ft. of full-size tiles.
09 54 36	SUSPENDED DECORATIVE GRIDS	Suspended Decorative Grids	100 sq. ft. of each suspended decorative grid component, exposed molding, and trim.
09 68 13	TILE CARPETING	Carpet Tile	100 sq. ft. of full-size units for each type indicated.
12 21 13	HORIZONTAL LOUVER BLINDS	Horizontal Louver Blinds	Full-size units equal to 1 percent of quantity installed for each size, color, texture, pattern, and gloss indicated, but no fewer than two units and no more than five units.
21 05 00	FIRE SUPRRESION	Sprinkler heads and Special Sprinkler Wrenches.	2 heads minimum of each type and temperature rating installed and special sprinkler wrenches enclosed in a steel cabinet in accordance with NFPA 13.
23 30 00	HVAC AIR DISTRIBUTION	Fire Dampers	3 fusible links per type installed.
26 20 00	LOW VOLTAGE ELECTRICAL DISTRIBUTION	Fuses	1 set of 3 of each type and size used on the project and fuse cabinet in main electrical room to hold them.
26 51 00	INTERIOR LIGHTING	Lamps	Provide 5% or a maximum of 25 spares of each lamp type used on the project.
28 31 00	FIRE DETECTION AND ALARM	Initiating and Control Devices	Provide 5 spare devices for each device type used.
		Notification Devices	Provide 5 spare devices for each device type used.

END OF SECTION 01 78 46

SECTION 01 79 00 DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing University's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include outline for each training module.

B. Qualification Data: For instructor, demonstrating qualifications and ability to instruct on maintenance and care of system, equipment and products.

C. Schedule of Demonstration and Training: Prepare a schedule in tabular form of all demonstration and training required in individual Specification Sections including:

1. Specification Section number and title.
2. Description of required demonstration and training.

D. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training. Manufacturer’s sales staff is not acceptable.

B. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to demonstration and training.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations manuals.
    c. Maintenance manuals.
    d. Project record documents.
    e. Identification systems.
    f. Warranties and bonds.
    g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.
    g. A tour of the installation identifying the location of all system components.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.
    f. Safety procedures.
    g. Instructions on stopping.
    h. Normal shutdown instructions.
    i. Operating procedures for emergencies.
    j. Operating procedures for system, subsystem, or equipment failure.
    k. Seasonal and weekend operating instructions.

l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.
n. Sequence of operation.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.
f. Product support/service model.
g. Purchasing of replacement parts.

9. Instruction specific to Instrumentation and Controls, Electrical Gateway, Network Lighting Controls, or any other new technology that is integrated with another system: Include the following:

a. Overview and theory.
b. Wiring diagrams, including the one line diagram.
c. Creation, editing, and programming of the point database.
d. Integration topology and platform for communication.
e. Graphics packages and touch screens for the system.
f. Alarms and diagnostics.
g. Reporting functions dynamically and historically.
h. Remote access to the system.
i. Database back-up and maintenance.
j. Replacement and re-programming of replacement parts.
k. Point type and functionality for each type of point.
l. Programming.
m. Point/object editing.
n. Loop tuning.
o. Help files and other troubleshooting documentation.

p. Instruction is given by the staff that setup the integration.

C. Operation and Maintenance Manuals: Provide appropriate Operation and Maintenance manuals in each training session so that the detail drawings and maintenance activities are outlined and discussed for each application.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module.

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Engage qualified instructors to instruct University's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. University will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Coordinate schedule for all training with University Project Manager and provide the following:

a. Minimum 3 weeks notification.
b. Training matrix in calendar format.
c. Training outline for each session.

2. Do not schedule training until equipment has been started up, commissioned, and is currently operating in its normal condition.
3. Do not schedule overlapping training sessions.
4. Schedule training sessions for a maximum of 4 hours per day; afternoons preferred.
5. Provide separate training session on each system for operational/maintenance groups and user groups.
6. Training sessions will be cancelled and rescheduled unless the following documentation is received:

a. Instruction qualifications.
b. Evidence that equipment has been started up, commissioned, and is currently operating in its normal condition.
c. Operation and Maintenance manuals.

C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

D. Travel, Room and Board: Coordinate any out-of-state training with the University Project Manager.

E. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION SCHEDULE

SECTION	TITLE	DESCRIPTION
23 00 00	HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)	Schedule instructional meetings for The University of Colorado Anschutz Medical Campus Facilities Operations maintenance personnel on the proper operation and maintenance of mechanical systems. Provide the project manager a minimum of 5 days notice prior to any testing.
23 09 00	INSTRUMENTATION AND CONTROLS	Engage a factory-authorized trained representative to conduct a minimum of 1-four hour on-site training course and an additional 1-four hour on-site training course per 25,000 sq. ft. for designated University personnel.
		Engage a factory-authorized trained representative to conduct an 8-hour seasonal loop training.

END OF SECTION 01 79 00

SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adhered EPDM membrane roofing system.

1.2 PERFORMANCE REQUIREMENTS

A. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

B. Source Limitations: Obtain components including for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.

C. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

1.5 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

PART 2 - PRODUCTS

2.1 EPDM MEMBRANE ROOFING

A. EPDM: ASTM D 4637, Type I, non-reinforced, uniform, flexible EPDM sheet.

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

   a. Carlisle SynTec Incorporated.
   b. Firestone Building Products.
   c. Versico Incorporated.

2. Thickness: 60 mils (1.5 mm) – match existing, nominal.
3. Exposed Face Color: Black.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Contact Adhesive: 80 g/L.
   f. Single-Ply Roof Membrane Sealants: 450 g/L.
   g. Nonmembrane Roof Sealants: 300 g/L.
   h. Sealant Primers for Nonporous Substrates: 250 g/L.
   i. Sealant Primers for Porous Substrates: 775 g/L.
   j. Other Adhesives and Sealants: 250 g/L.

B. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.

C. Bonding Adhesive: Manufacturer's standard.

D. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film.

E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

F. Miscellaneous Accessories: Provide lap sealant, water cutoff mastic, metal termination bars, metal battens, pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

G. Coating: 100% Acrylic, single component, water-based elastomeric coating.

1. Match existing coating color.

2.3 SUBSTRATE BOARDS

A. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.

2.4 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

2.5 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

B. Insulation Adhesive: Insulation manufacturer's recommended cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

PART 3 - EXECUTION

3.1 SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

3.2 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

D. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

3.3 ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere membrane roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.

B. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.

D. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.

E. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.

F. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.

G. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

3.4 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings.

3.5 FIELD QUALITY CONTROL

A. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

END OF SECTION 075323

SECTION 078413 – PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Firestopping of penetrations in fire-rated assemblies.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FIRESTOPPING - GENERAL

A. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

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

a. Hilti, Inc.
b. 3M; Fire Protection Products Division.

B. Sealants, caulking materials, or foams for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:

1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)

C. Sealants, caulking materials, or foams for use with sheet metal ducts, following products are acceptable:

1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

END OF SECTION 078413

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Interior gypsum board.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 INTERIOR GYPSUM BOARD

A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.

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

a. G-P Gypsum.
b. Lafarge North America Inc.
c. National Gypsum Company.
d. PABCO Gypsum.
e. Temple.
f. USG Corporation.

B. Type X:

1. Thickness: 5/8 inch (15.9 mm).
2. Long Edges: Tapered.

C. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.

1. Thickness: 1/2 inch (12.7 mm).
2. Long Edges: Tapered.

2.2 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:

    a. Cornerbead.
    b. L-Bead: L-shaped; exposed long flange receives joint compound.
    c. Expansion (control) joint.

2.3 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

3.2 APPLYING INTERIOR GYPSUM BOARD

A. Match existing gypsum board in type and thickness.

3.3 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners, unless otherwise indicated].

3.4 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below:

1. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.

a. Primer and its application to surfaces are specified in other Division 09 Sections.

3.5 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 SUBMITTALS

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

B. Samples: For each exposed finish.

1.3 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. Acoustical Ceiling Panels: Full-size panels equal to [**2.0**] <**Insert number**> percent of quantity installed.
2. Suspension System Components: Quantity of each exposed component equal to [**2.0**] <**Insert number**> percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANEL CEILINGS, GENERAL

A. Acoustical Panel Standard: Comply with ASTM E 1264.

B. Metal Suspension System Standard: Comply with ASTM C 635.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

D. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

1. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.

E. Seismic perimeter stabilizer bars, seismic struts, and seismic clips.

F. Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Manufacturers: Subject to compliance with requirements, provide one of the following:

1. Armstrong World Industries, Inc.;
2. CertainTeed, Inc
3. USG Interiors, Inc.;

B. Basis-of-Design Product: Match existing ceiling tiles in size and pattern.

C. Classification: Provide panels complying with ASTM E 1264 for type and form as follows:

1. Type and Form: Type III, mineral base with painted finish; Form 1, nodular

D. Color: White

E. Edge/Joint Detail: Match existing.

F. Thickness: 3/4 inch (19 mm).

G. Modular Size: Match existing.

2.3 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Manufacturers: Subject to compliance with requirements, provide one of the following:

1. Armstrong World Industries, Inc.
2. Chicago Metallic Corporation
3. CertainTeed, Inc.
4. USG Interiors, Inc.

B. Basis-of-Design Product: Match existing. Paragraph and subparagraphs below are examples only; revise to suit Project.

C. Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Match existing.
3. Cap Material: Steel or aluminum cold-rolled sheet.
4. Cap Finish: Painted white.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders.

C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
2. Do not attach hangers to steel deck tabs or to steel roof deck.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

END OF SECTION 095113

SECTION 09912 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Gypsum board.

1.2 SUBMITTALS

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

B. Samples: For each finish and for each color and texture required.

C. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.3 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.4 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
3. Flat Topcoat Paints: VOC content of not more than 50 g/L.
4. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.

C. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:

a. Acrolein.
b. Acrylonitrile.
c. Antimony.
d. Benzene.
e. Butyl benzyl phthalate.
f. Cadmium.
g. Di (2-ethylhexyl) phthalate.
h. Di-n-butyl phthalate.
i. Di-n-octyl phthalate.
j. 1,2-dichlorobenzene.
k. Diethyl phthalate.
l. Dimethyl phthalate.
m. Ethylbenzene.
n. Formaldehyde.

o. Hexavalent chromium.
p. Isophorone.
q. Lead.
r. Mercury.
s. Methyl ethyl ketone.
t. Methyl isobutyl ketone.
u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene).
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

D. Colors: As selected by Architect from manufacturer's full range.

2.2 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 3.

2.3 LATEX PAINTS

A. Interior Latex (Flat): MPI #53 (Gloss Level 1).

1. VOC Content: E Range of E3.
2. Environmental Performance Rating. : EPR 2.5

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION AND APPLICATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.3 INTERIOR PAINTING SCHEDULE

A. Gypsum Board Substrates:

1. Latex System: MPI INT 9.2A.

a. Prime Coat: Interior latex primer/sealer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (flat).

END OF SECTION 099123

SECTION 22 0500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. Description of Systems
1. The work of Division 22 includes but is not limited to Domestic Water, Sanitary waste and Vent, Storm Drainage, and any other drainage system.

B. Work Included
1. Furnish all labor and materials and perform all operations necessary for the installation of complete and operating plumbing systems subject to the conditions of the contract. The work also includes the completion of such mechanical, plumbing and electrical details not mentioned or shown which are necessary for the successful operation of all systems; this includes the furnishing of all materials for filling systems to make them operable, including water, refrigerant, oil and grease. Prove satisfactory operation of all equipment and controls to the Consulting Mechanical Engineer on request.
2. Equipment manufacturer's noted in equipment schedules on the drawings take precedence. Manufacturer's noted on the drawings will be used for the basis of design.

C. Work Not Included (Specified Elsewhere)
1. Certain labor and materials may be furnished and/or installed under other divisions of these specifications. Coordinate with other trades and arrange the work to make the parts fit together. The following items are to be accomplished under other divisions of these specifications.
2. Fixed concrete bases for equipment: Division 3. Anchor bolts, setting diagrams, base sizes and other required information furnished under Division 22.
3. Wall openings and Chases: Under applicable sections according to information furnished under Division 22.
4. Access Panels: Furnished and located by Division 22 installer as specified in Division 8 for installation by appropriate trades.
5. Painting (except plumbing identification systems): Division 9.

D. Equipment Furnished by Owner
1. General: Also see Division 1.
2. Rough-in service pipes to locations as required by architectural and Plumbing drawings and equipment shop drawings. Provide service valves on all pipes except waste and vent pipes, plug or cap these. Final connections to equipment will be made Contractor. (This Contractor will provide all necessary equipment or items required for final connections to equipment).

E. Examination of Premises
1. Visit the premises before submitting bid as no extras will be allowed for lack of knowledge of existing conditions.

F. Inspection
1. Inspect work proceeding or interfacing with work of Division 22 Sections and report any known or observed defects that affect the work to the General Contractor. Do not proceed with work until defects are corrected.

G. Definitions
1. "Provide" means Contractor is responsible for the furnishing and installation of.
2. "Exposed" means visible from the floor of a room or area.
3. "Concealed" means in such spaces as pipe chases, pipe trenches, above plaster ceilings, in walls and buried where pipe is inaccessible when building is completed.

4. "Conditioned" space, means any space which is within the exterior insulation boundary or layer and is heated by the mechanical system or by an adjacent space. Mechanical rooms and ceiling plenums are classified as "conditioned" spaces.
5. "Mechanical Room" means any space or area which contains equipment providing heating, cooling, ventilation, plumbing distribution, or mechanical/plumbing system utility generation and distribution capabilities. These spaces are defined as "Mechanical Rooms" even if they are called by another name (i.e. boiler room, chiller room, machine room, etc.).

1.2 COORDINATION

A. General
   1. Coordinate and order the progress of work to conform to the Owner's schedule and the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Utility Interruptions
   1. Coordinate utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

C. Cutting and Patching
   1. See Division 1 Section 01 7000.

D. Drawings and Specifications
   1. Plumbing drawings are diagrammatic and because of the small scale, it is not possible to indicate every required offset, fitting, etc. Drawings are not to be scaled for dimensions. Take all dimensions from Architectural drawings, certified equipment drawings and from the structure itself before fabricating any work. Verify all space requirements, coordinating with other trades, and install the systems in the space provided without extra charges to the Owner.
   2. Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the General Contractor and obtain written instructions for any changes necessary.
   3. All documents are complimentary. What is required by one document is binding as if by all.

E. Confer, cooperate, and coordinate work with other trades. Coordinate ceiling cavity space carefully with all trades. In event of conflict, install mechanical and electrical systems within cavity space in following order of priority.
   1. Plumbing waste and vent piping.
   2. Roof drain piping.
   3. Ductwork.
   4. Electrical conduit and lighting.
   5. Domestic hot and cold water piping.
   6. Fire sprinkler piping.

F. Prior to ordering equipment, determine that equipment will adequately pass through building openings and passageways providing unobstructed access to final equipment location. Equipment shall be manufactured and shipped in sections for assembly in final equipment location when inadequate building openings and passageways limit access. Shop drawings and submittals shall indicate sectionalized manufacturing of equipment.

1.3 REFERENCE STANDARDS

A. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. The date of the standards that is in effect at the bid date, or date of Owner/Contractor Agreement when there are no bids, except when a specific date is specified or when the standard is part of an applicable code which includes an edition date.

C. When required by individual Specification section, obtain copy of standard. Maintain copy at job site during work until Substantial Completion.

1.4 REGULATORY AND CODE REQUIREMENTS

A. Apply for and pay for all permits (plan review fees), fees, licenses and inspections for this Division of work.

B. Do not include the cost of any "Plant Investment Fee" or "System Development Charge" for sewer and/or water charged by the City. This will be arranged for and paid for by the Owner.

C. Do not include the cost of any "Gas Application Fee" charged by the Utility Company. This will be arranged for and paid for by the Owner.

D. Comply with state and local code requirements and ordinances. Comply with requirements of the Utility Companies. In the case of differences between these requirements and ordinances, the most stringent shall govern. Call for inspections required by local building inspection authority.

1.5 TEMPORARY CONSTRUCTION FACILITIES

A. General
1. Comply with Division 1.

B. Temporary Water Supply
1. Temporary Water Supply will be furnished by the General Contractor.
2. See Division 1. Use of the permanent Water Distribution system will not be allowed without written authorization from the Owner. In case where the permanent water distribution system is approved for temporary usage, the General Contractor shall pay all costs until acceptance by the Owner. These costs shall include but not be limited to water, chemical treatment, salt and filter media.
3. Systems used for temporary water supply are the Contractor's responsibility to maintain, and put into first class working order before acceptance by the Owner. Domestic water distribution piping shall be chlorinated and purged upon project completion and acceptance by Owner.
4. Equipment warranties that start with the use of equipment for temporary water supply shall be extended by the Contractor so that the Owner will have the full one year warranty required by the Contract Documents from the date of acceptance of the building or space.

1.6 PRODUCT REQUIREMENTS

A. General
1. Comply with Division 1 Section 01 6000.
2. Material, equipment or service specified by name is used as a basis of design. Equivalents to items named in the specifications may be used if accepted before bidding. Requests for acceptance shall be received at the Consulting Mechanical Engineer's office at least 10 calendar days before bid opening.
3. When any product is specified only by requirement to meet an industry standard or regulating body standard (such as U.L. AGA, AWWA, ANSI, etc.) and the item proposed carries approval of that body, no prior acceptance by the Consulting Mechanical Engineer is needed.
4. When any product or service is specified by requirement to meet a performance standard or is specified by a generic specification, (no manufacturers name listed) no prior acceptance by the Consulting Mechanical Engineer is needed except as specifically called for in these specifications.

B. Substitutions
1. Comply with section 01 6000 – Product Requirements for substitution procedures.

2. Materials, equipment or services listed by several identifying names are intended to be bidder's choice, and any of the listed names may be bid without soliciting prior acceptance. Where more than one name is given in the specifications, the first named manufacturer's material, equipment or services is contemplated and any changes and their costs, required to accommodate the other named material or equipment as well as space requirements for the other named materials or equipment, must be assumed by the Contractor in his bid.
3. Material and equipment specified is used as a basis of standard, and while not specifically mentioned, material gauges, weights, appearance and space requirements must be met by any substitutions.

1.7 SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Submittals are to be handled in groups, each processed in a different manner as follows:
1. Items furnished that are specified by industry or regulating body standard and/or by performance or generic specification. Copies shall be included in the Operating and Maintenance Instruction Manuals.
2. Provide submittals for all materials and equipment named in these specifications showing any changes required in piping, ducting, electrical wiring, space allocation etc. Be responsible to make all changes required to accommodate and to pay for these changes. Coordinate changes required with all other trades. Pay for all changes resulting from re-arranging equipment.
3. The following items require submittals prior to commencing work:
   a. All fixtures and equipment, including items called out by manufacturers name and model number.
   b. All substituted items – see section 01 6000 – Product Requirements for substitution procedures.
   c. Motors, Phase Protection.
   1) Include copies of these in the Operating and Maintenance manuals. Submit shop drawings with one item per sheet so that a file may be set up for each specified item.
   2) Fire protection and other submittals requiring drawings or diagrams shall be submitted on the same size drawing and format, and the same type of medium as the construction document drawings.

1.8 CLEANING

A. Comply with Division 1.

B. Clean exposed surfaces of piping, hangers, and other exposed items of grease, dirt or other foreign material. Remove rubbish and debris resulting from the operations and leave equipment spaces clean and ready for use. Refinish or repaint items at the discretion of the Architect.

1.9 PROJECT RECORD DOCUMENTS

A. Comply with section 01 7800 – closeout submittals for submittal requirements and procedures.

1.10 OPERATION AND MAINTENANCE DATA

A. Comply with section 01 7800 – closeout submittals for submittal requirements and procedures.

B. The manuals shall contain, but not be limited to, the following general items; each item shall be provided with a separate index tab.
1. Instructions (On Contractor's Letterhead Stationery) on who to call for service during guarantee period including name, address, and 24 hour telephone number of company responsible for servicing each piece of equipment or system.
2. Maintenance instructions (On Contractor's Letterhead Stationery) shall include: (can be referenced to manufacturer's manual with appropriate page numbers, etc.)
   a. Preventative maintenance schedule for necessary cleaning, replacement and/or adjustment of all pumps, fixtures, and water heaters.

b. Cleaning schedule of all strainers, traps, coils, tubes, tower pans, sprays, etc.
c. Lubrication charts showing type of lubricant and application methods and frequencies for each piece of equipment.
d. Water treatment recommendations for domestic water systems.

3. Manufacturer's manuals (current originals, copies are not acceptable) for each piece of equipment installed (including equipment not requiring submittals or shop drawings) identified by drawing code numbers as they appear on the drawing and in the specifications. Manuals shall include the following, as applicable:
   a. Description of unit and component parts:
   1) Function, normal operating characteristics and limiting conditions.
   2) Performance curves, engineering data and tests for pumps. Curves shall include flow rate, pressure, HP, RPM and efficiency.
   3) Complete nomenclature and commercial part number of replaceable parts.
   4) Installation instruction sheets.
   5) Complete wiring diagrams
   b. Recommended procedures:
   1) Start-up, break-in, routine lubrication and operating instructions and cautions.
   2) Regulation, control, start/stop, shut-down and emergency instructions.
   3) Special summer and winter operating cautions.
   c. Maintenance
   1) Routine care
   2) Guide to trouble shooting
   3) Disassembly, repair and reassembly
   4) Alignment, adjusting and checking
   5) Water treatment
   6) List of required lubricants and replacement schedule
   7) Filter cleaning or replacement schedule
   8) Parts list, illustrations, assembly drawings and diagrams required for maintenance.
   9) Predicted life of parts subject to wear
4. All warranties provided by the Manufacturer on their equipment that run longer than the warranty by the Contractor.
5. Valve chart(s) with schematic floor diagrams indicating valve locations with numbers labeled on valve chart.
6. All equipment start up logs including certification of start up by manufacturer.
7. Balance Reports: circulated hot water
8. All pipe pressure test certifications.
9. Domestic water sterilization certification.

C. Provide lubrication and water filter maintenance charts, to be mounted adjacent to or on equipment. Charts shall provide information as noted above and shall provide a means for maintenance personnel to record when and what maintenance was accomplished.

D. These O & M manuals shall be considered a part of the final observation and shall be submitted for approval at least fifteen days prior to a request for a final observation.

1.11 WARRANTIES

A. Comply with Division 1.

B. All materials and equipment shall be new otherwise specified.

C. Provide a written warranty to the Owner covering the entire plumbing work to be free from defective materials, equipment and workmanship for a period of one year after date of substantial completion. During this period provide labor and materials as required to repair or replace defects at no additional cost to the Owner. Provide certificates (include in O & M Manuals) for such materials or equipment which have warranties in excess of one year(s). Include dates of start and end of the warranty and manufacturer's representative name and telephone number.

D. This warranty will be superseded by warranty modifications resulting from use of equipment for construction heating or cooling.

1.12 DEMONSTRATIONS and TRAINING

A. Comply with section 01 7800 – closeout submittals for submittal requirements and procedures.

1.13 EXECUTION

A. Workmanship
1. Perform work in accordance with good commercial practice. The appearance of the finished work shall be of equal importance with its mechanical efficiency. The Architect/Engineer may reject work if workmanship and appearance are not satisfactory.

B. Supervision
1. Be responsible for and coordinate the work of all subcontractors working under Division 22.

C. Installation Procedures
1. Confer and cooperate with other trades and coordinate the work in proper relation with theirs. Coordinate ceiling cavity space carefully with other trades.

D. Properly locate anchors, chases, recesses and openings for the proper installation of the work. Arrange with the proper contractors for the building of anchors, etc. and for the leaving of the required chases, recesses and openings.

E. Install all work to permit removal (without damage to other parts) of coils, heat exchanger bundles, and all other parts which might require periodic replacement or maintenance. Arrange pipes, and equipment to permit ready access to valves, traps, starters, motors, control components and to clear the openings of doors and of access panels.

F. Offsets, transitions and changes in direction in pipes shall be made as required. Maintain proper head room and pitch of sloping pipes whether or not indicated on the drawings. Furnish and install all traps, air vents, sanitary vents, etc., as required to effect these offsets, transitions and changes in direction.

G. Install equipment and materials in accordance with manufacturers' recommendations unless specifically indicated otherwise, or where local codes or regulations take precedence.

H. Conceal all piping in finished areas of the building except where otherwise noted on the drawings.

I. Protection
1. Where there are existing facilities, be responsible for the protection thereof, whether or not such facility is to be removed or relocated. Moving or removing any piping or equipment must be done so as not to cause interruption of the work or Owner's operation.
2. Close ends of pipe during construction with caps or plugs to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Protect fixtures and equipment against damage during mechanical work.
3. Provide protection for concrete slabs where cutting or threading of piping occurs, storage of equipment, etc.

J. Piping Testing: See Respective Division 22 Sections

END OF SECTION

SECTION 22 0517

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

1.02 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop collar.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated, with plain ends and integral welded water stop collar.

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

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.02 STACK-SLEEVE FITTINGS

A. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

A. Description:
1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.

3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel or Stainless steel, Type 316.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 or Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.04 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall.

B. Plastic or rubber water stop collar with center opening to match piping OD.

2.05 GROUT

A. Description: Non-shrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

D. Packaging: Premixed and factory packaged.

2.06 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

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

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 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 or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 8413 "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 6200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.03 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.

3.04 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.06 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 pipe sleeves, Steel pipe sleeves, Sleeve-seal fittings.
b. Piping NPS 6and Larger: Cast-iron pipe sleeves, Steel pipe sleeves, Sleeve-seal fittings.

2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system, Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system, Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-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 pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system, Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system, Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
   a. Piping Smaller Than NPS 6: Steel pipe sleeves, Stack-sleeve fittings, Sleeve-seal fittings.
   b. Piping NPS 6 and Larger: Steel pipe sleeves, Stack-sleeve fittings.
5. Interior Partitions:
   a. Piping Smaller Than NPS 6: Steel pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION

SECTION 22 0518

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.03 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.02 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
   1. Escutcheons for New Piping and Relocated Existing Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
      b. Chrome-Plated Piping: One-piece cast brass or split-casting brass with polished, chrome-plated finish.
      c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with set screw and polished, chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:
   a. Chrome-Plated Piping: Split-casting, stamped steel with concealed hinge with polished, chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping and Relocated Existing Piping: One-piece, floor plate.
   2. Existing Piping: Split floor plate.

3.02 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 22 0519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Thermowells.
5. Dial-type pressure gages.
6. Gage attachments.
7. Test plugs.
8. Test-plug kits.
9. Sight flow indicators.

1.02 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Certificates: For each type of meter and gage.

1.04 CLOSEOUT SUBMITTALS

A. Comply with section 01 7800 – closeout submittals for submittal requirements and procedures.

B. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Case: sealed type(s); stainless steel with 3-inch nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass or plastic.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.02 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass or plastic.
8. Ring: Stainless steel.
9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    a. Design for Thermowell Installation: Bare stem.
11. Accuracy: Plus or minus 1 percent of scale range.

2.03 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum; 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.
    a. Design for Thermowell Installation: Bare stem.
8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.
    a. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.04 THERMOWELLS

A. Thermowells:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CSA.

5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.05 PRESSURE GAGES

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

2.06 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.07 TEST PLUGS

A. Description: Test-station fitting made for insertion into piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.08 TEST-PLUG KITS

A. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

B. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

C. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.

D. Carrying Case: Metal or plastic, with formed instrument padding.

2.09 SIGHT FLOW INDICATORS

A. Description: Piping inline-installation device for visual verification of flow.

B. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

C. Minimum Pressure Rating: 150 psig.

D. Minimum Temperature Rating: 200 deg F.

E. End Connections for NPS 2 and Smaller: Threaded.

F. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:
1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.

L. Install pressure gages in the following locations:
1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.02 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

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

3.04 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
1. Sealed, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Metal case, industrial-style, liquid-in-glass type.
4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
   1. Sealed, bimetallic-actuated type.
   2. Direct-mounted, metal-case, vapor-actuated type.
   3. Metal case, industrial-style, liquid-in-glass type.
   4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
   1. Sealed, bimetallic-actuated type.
   2. Direct-mounted, metal-case, vapor-actuated type.
   3. Metal case, industrial-style, liquid-in-glass type.
   4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:
   1. Sealed, bimetallic-actuated type.
   2. Direct-mounted, plastic-case, vapor-actuated type.
   3. Metal case, industrial-style, liquid-in-glass type.
   4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

E. Thermometer stems shall be of length to match thermowell insertion length.

3.05 THERMOMETER SCALE-RANGE SCHEDULE

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

B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

C. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F.

3.06 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:
   1. Liquid-filled, direct-mounted, metal case.
   2. Sealed, direct-mounted, metal case.
   3. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
   1. Liquid-filled, direct-mounted, metal case.
   2. Sealed, direct-mounted, metal case.
   3. Test plug with EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
   1. Liquid-filled, direct-mounted, metal case.
   2. Sealed, direct-mounted, metal case.
   3. Test plug with EPDM self-sealing rubber inserts.

3.07 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi.

B. Scale Range for Domestic Water Piping: 0 to 160 psi.

END OF SECTION

SECTION 22 0523.12

BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

A. CWP: Cold working pressure.

1.03 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of valve.
1. Certification that products comply with NSF 61and NSF 372.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball 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 operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

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

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

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

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

G. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
   1. Include 2-inch stem extensions.
   2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

2.02 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. NIBCO INC.
      c. WATTS.
   2. Description:
      a. Standard: MSS SP-110 or MSS-145.
      b. CWP Rating: 600 psig
      c. Body Design: Two piece.
      d. Body Material: Bronze.
      e. Ends: Threaded or soldered.
      f. Seats: PTFE.
      g. Stem: Stainless steel.
      h. Ball: Stainless steel, vented.
      i. Port: Full.

2.03 CPVC BALL VALVES

A. CPVC Union Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. IPEX USA LLC.
      c. Jomar Valve.
      d. Legend Valve & Fitting, Inc.
      e. Spears Manufacturing Company.
   2. Description:
      a. Standard: MSS SP-122.
      b. Pressure Rating and Temperature: 150 psig at 73 deg F.
      c. Body Material: CPVC.
      d. Body Design: Union type.
      e. End Connections for Valves NPS 2 and Smaller: Detachable, socket.
      f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or flanged.
      g. Ball: CPVC; full port.
      h. Seals: PTFE or EPDM-rubber O-rings.
      i. Handle: Tee shaped.

B. CPVC Non-Union Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. IPEX USA LLC.
      c. Jomar Valve.
      d. Legend Valve & Fitting, Inc.
      e. Spears Manufacturing Company.

2. Description:
   a. Standard: MSS SP-122.
   b. Pressure Rating and Temperature: 150 psig at 73 deg F.
   c. Body Material: CPVC.
   d. Body Design: Non-union type.
   e. End Connections: Socket or threaded.
   f. Ball: CPVC; full or reduced port.
   g. Seals: PTFE or EPDM-rubber O-rings.
   h. Handle: Tee shaped.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 22 0553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.04 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze ball valves, two-piece with full port and stainless steel trim. Provide with threaded, solder, or press connection-joint ends.

B. Pipe NPS 2-1/2 and Larger:
   1. Steel ball valves, Class 150 with full port.
   2. Iron ball valves, Class 150.

C. CPVC Pipe NPS 4 and Smaller: Union-ball or Non-union ball valve.

END OF SECTION

SECTION 22 0529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Metal 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 Requirements:
1. Section 05 5000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 22 0516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 22 0548.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.02 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product.

C. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

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

1.03 INFORMATIONAL SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Welding certificates.

1.04 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. 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.
   3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.02 METAL PIPE HANGERS AND SUPPORTS

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

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, 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.

2.04 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. B-line; Eaton, Electrical Sector.
      b. G-Strut.
      c. Unistrut; Atkore International.
   2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
   4. Channels: Continuous slotted carbon-steel or stainless-steel, Type 304 channel with inturned lips.
   5. Channel Width: Selected for applicable load criteria.

6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
8. Paint Coating: Green epoxy, acrylic, or urethane.
9. Plastic Coating: PVC.

B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Anvil International.
   b. Eberl Iron Works, Inc.
   c. FNW; Ferguson Enterprises, Inc.
   d. HOLDRITE; Reliance Worldwide Company.
   e. PHD Manufacturing, Inc.
   f. Sioux Chief Manufacturing Company, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel or stainless-steel channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
8. Paint Coating: Green epoxy, acrylic, or urethane.
9. Plastic Coating: PVC.

2.05 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Pipe Shields Inc.
2. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-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.

2.06 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: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
   c. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, 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: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. B-line; Eaton, Electrical Sector.
      b. Empire Tool and Manufacturing Co., Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      e. MKT Fastening, LLC.
   2. Indoor Applications: Zinc-coated or stainless steel.
   3. Outdoor Applications: Stainless steel.

2.07 PIPE STANDS

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

B. Compact Pipe Stand:
   1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate. Hardware: Galvanized steel or polycarbonate.
   3. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:
   1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
   3. Vertical Members: Two galvanized or stainless-steel, continuous-thread, 1/2-inch rods.
   4. Horizontal Member: Adjustable horizontal, galvanized or stainless-steel pipe support channels.
   5. Pipe Supports: Strut clamps.
   6. Hardware: Galvanized or Stainless-steel.
   7. Accessories: Protection pads.
   8. Height: 12 inches above roof.

D. High-Profile, Single-Base, Single-Pipe Stand:
   1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Single vulcanized rubber or molded polypropylene.
   3. Vertical Members: Two galvanized or stainless-steel, continuous-thread, 1/2-inch rods.
   4. Horizontal Member: One adjustable-height, galvanized- or stainless-steel, pipe-support slotted channel or plate.
   5. Pipe Supports: Roller.
   6. Hardware: Galvanized or Stainless-steel.

E. High-Profile, Multiple-Pipe Stand:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: Two or more; vulcanized rubber.
   3. Vertical Members: Two or more, galvanized or stainless-steel channels.
   4. Horizontal Members: One or more, adjustable-height, galvanized or stainless-steel pipe support.
   5. Pipe Supports: Roller.
   6. Hardware: Galvanized or Stainless-steel.

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

2.08 PIPE-POSITIONING SYSTEMS

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

2.09 EQUIPMENT SUPPORTS

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

2.10 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Non-staining, non-corrosive, and non-gaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 07 8413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

E. 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.

2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 7200 "Roof Accessories" for curbs.

G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. 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.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. 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.

M. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. 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.

O. 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 of same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 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.

3.06 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 9113 "Exterior Painting." Section 09 9600 "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.07 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

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

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

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

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated 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 non-insulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, 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 occurs.
   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 occurs.
   19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
   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 occurs and vertical adjustment is unnecessary.
   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, in addition to expansion and contraction, is required.

K. 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.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment of 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.

M. 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.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

O. 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.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

END OF SECTION

SECTION 22 0553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.02 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

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

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

E. Valve-numbering scheme.

F. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Brass, 0.032-inch, stainless steel, 0.025-inch, aluminum, 0.032-inch, anodized aluminum, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of 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.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Brady Corporation.

b. Brimar Industries, Inc.
c. Seton Identification Products; a Brady Corporation company.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of 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 of 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 rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.02 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of 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.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Seton Identification Products; a Brady Corporation company.

B. Material: Vinyl.

C. Minimum Thickness: 0.005 inch.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: 160 deg F.

G. Minimum Width: 2 inches.

2.04 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Kolbi Pipe Marker Co.
4. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.05 STENCILS

A. Stencils for Piping:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Brimar Industries, Inc.
b. Kolbi Pipe Marker Co.
2. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Aluminum, brass, or fiberboard.
4. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, acrylic enamel in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

2.06 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Kolbi Pipe Marker Co.
4. Seton Identification Products; a Brady Corporation company.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04-inch, stainless steel, 0.024-inch, aluminum, 0.031-inch or anodized aluminum, 0.031-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. 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. Include valve-tag schedule in operation and maintenance data.

2.07 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Kolbi Pipe Marker Co.
4. Seton Identification Products; a Brady Corporation company.

B. Description: Preprinted accident-prevention tags of plasticized card stock.
1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.
1. White letters on an ANSI Z535.1 safety-green background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.04 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.05 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Section 09 9123 "Interior Painting." Section 09 9600 "High-Performance Coatings."

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

F. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

G. Pipe-Label Color Schedule:
1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
4. Sanitary Waste and Storm Drainage Piping: White letters on a black background.

3.06 INSTALLATION OF VALVE TAGS

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 in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
1. Valve-Tag Size and Shape:
a. Domestic Cold Water: 1-1/2 inches, round.
b. Domestic Hot Water: 1-1/2 inches, round.
c. Domestic Hot-Water Return: 1-1/2 inches, round.
2. Valve-Tag Colors:
a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

3.07 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where indicated on Drawings.

END OF SECTION

SECTION 22 0593

TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: (Not all apply to the project):
   1. TAB of domestic water system.
   2. Pipe-leakage test verification.
   3. Testing, adjusting, and balancing of existing plumbing systems and equipment.

1.02 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.03 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details.
   1. Minimum Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Needs for coordination and cooperation of trades and subcontractors.
      d. Proposed procedures for documentation and communication flow.

1.04 INFORMATIONAL SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Qualification Data: Within 10 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 10 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

D. Strategies and Procedures Plan: Within 10 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

E. System Readiness Checklists: Within 10 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

G. Certified TAB reports.

H. Sample report forms.

I. 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.

1.05 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB or TABB:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.

E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."

F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.06 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

A. 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 installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.
   1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on plumbing equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Domestic Water System:
      a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
      b. Water heaters are installed and functioning.
      c. Piping is complete and all points of outlet are installed.
      d. Water treatment is complete.
      e. Systems are flushed, filled, and air purged.
      f. Strainers are clean.
      g. Control valves are functioning in accordance with the sequence of operation.
      h. Shutoff and balance valves are 100 percent open.
      i. Booster- and hot-water circulating pumps are operational and proper rotation is verified.
      j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
      k. Variable-frequency controllers' startup is complete and safeties are verified.
      l. Suitable access to balancing devices and equipment is provided.
   2. Sanitary Sewage/Drainage System:
      a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
      b. Piping is complete.
      c. Sanitary sewage pumps/drainage pumps are operational.
      d. Control valves are functioning in accordance with the sequence of operation.
      e. Shutoff valves are 100 percent open.
      f. Suitable access to equipment is provided.
   3. Compressed-Air System:
      a. Leakage and pressure tests on compressed air distribution system have been satisfactorily completed in accordance with Division 22 requirements.

b. Piping is complete and all points of outlet are installed.
c. Systems are flushed, filled, and air purged.
d. Strainers are clean.
e. Control valves are functioning in accordance with the sequence of operation.
f. Shutoff and balance valves are 100 percent open.
g. Compressors are operational and of proper rotation.
h. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
i. Variable-frequency controllers' startup is complete and safeties are verified.
j. Suitable access to balancing devices and equipment is provided,

4. Vacuum System:
   a. Leakage and pressure tests on vacuum system have been satisfactorily completed in accordance with Division 22 requirements.
   b. Piping is complete and all points of inlet are installed.
   c. Systems are flushed, filled, and purged.
   d. Strainers are clean.
   e. Control valves are functioning in accordance with the sequence of operation.
   f. Shutoff and balance valves are 100 percent open.
   g. Vacuum pumps are operational and of proper rotation.
   h. Gauge connections are installed directly at vacuum pump inlet and outlet flanges prior to valves or strainers.
   i. Variable-frequency controllers' startup is complete and safeties are verified.
   j. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
   1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 22 0716 "Plumbing Equipment Insulation" and Section 22 0719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP units.

3.04 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
   1. Motors.
   2. Domestic water booster pumps.
   3. Domestic water in-line pumps.
   4. Domestic water heaters.
   5. Sanitary sewage pumps.
   6. Drainage pumps.
   7. Air compressors.

3.05 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
   1. Check expansion tank for proper setting.
   2. Check water heater for proper discharge temperature setting.
   3. Check remotest point of outlet for adequate pressure.
   4. Check flow-control valves for proper position.
   5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   6. Verify that motor controllers are equipped with properly sized thermal protection.
   7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.06 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:
   1. Check remotest point of outlet for adequate pressure.
   2. Check pressure-control valves for proper position.
   3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   4. Verify that motor controllers are equipped with properly sized thermal protection.

D. Measure and record upstream and downstream pressure of pressure-reducing valves.

E. Check settings and operation of pressure-reducing valves. Record final settings.

F. Check settings and operation of each safety valve. Record settings.

3.07 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the condition of filters.
   4. Check bearings and other lubricated parts for proper lubrication.
   5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Bearings and other parts are properly lubricated.
3. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated system flows of the renovated work to the measured flows, and determine the new pump speed.
2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the system flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

3.08 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:
1. Domestic Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
2. Compressed-Air Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

3.09 PROGRESS 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 system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

3.10 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

a. Indicated versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:
    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Gas-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in Btu/h.
    h. Ignition type.
    i. Burner-control types.
    j. Motor horsepower and speed.
    k. Motor volts, phase, and hertz.
    l. Motor full-load amperage and service factor.
    m. Sheave make, size in inches, and bore.
    n. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Entering-water temperature in deg F.
    c. Leaving-water temperature in deg F.
    d. Low-fire fuel input in Btu/h.
    e. High-fire fuel input in Btu/h.
    f. High-temperature-limit setting in deg F.
    g. Operating set point in Btu/h.
    h. Heating value of fuel in Btu/h.

F. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
    a. System identification.
    b. Location.
    c. Model number and unit size.
    d. Manufacturer's serial number.
    e. Output capacity in Btu/h.
    f. Number of stages.
    g. Connected volts, phase, and hertz.
    h. Rated amperage.
2. Test Data (Indicated and Actual Values):
    a. Heat output in Btu/h.

b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. High-temperature-limit setting in deg F.
e. Operating set point in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

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 speed.
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.
o. Full-load amperage and service factor.
p. Seal type.
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.

3.11 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of **Construction Manager or Commissioning Authority**.

B. **Construction Manager** or **Commissioning Authority** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either **10** percent of the total measurements recorded or the extent of measurements that can be accomplished in **a normal 8-hour business day**.

C. 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."

D. If the number of "FAILED" measurements is greater than **10** percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
   1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
   2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.12 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.

END OF SECTION

SECTION 22 0719

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulating the following plumbing piping services:
1. Domestic hot-water piping.
2. Domestic recirculating hot-water piping.
3. Sanitary waste piping exposed to freezing conditions.
4. Storm-water piping exposed to freezing conditions.
5. Roof drains and rainwater leaders.
6. Supplies and drains for handicap-accessible lavatories and sinks.

1.02 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

C. 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.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Preformed Pipe Insulation Materials: 12 incheslong by NPS 2.
2. Jacket Materials for Pipe: 12 incheslong by NPS 2.
3. Sheet Jacket Materials: 12 inchessquare.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.03 INFORMATIONAL SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Qualification Data: For qualified Installer.

C. 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.

D. Field quality-control reports.

1.04 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.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
   1. Piping Mockups:
      a. One 10-footsection of NPS 2straight pipe.
      b. One each of a 90-degree threaded, welded, and flanged elbow.
      c. One each of a threaded, welded, and flanged tee fitting.
      d. One NPS 2or smaller valve, and one NPS 2-1/2or larger valve.
      e. Four support hangers including hanger shield and insert.
      f. One threaded strainer and one flanged strainer with removable portion of insulation.
      g. One threaded reducer and one welded reducer.
      h. One pressure temperature tap.
      i. One mechanical coupling.
   2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
   3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   4. Obtain Architect's approval of mockups before starting insulation application.
   5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   7. Demolish and remove mockups when directed.

D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

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

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

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Block Insulation: ASTM C 552, Type I.
   2. Special-Shaped Insulation: ASTM C 552, Type III.
   3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   4. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Preformed Pipe Insulation:
   1. Type I, 850 Deg FMaterials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.03 ADHESIVES

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

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
   1. 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. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. 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. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. 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).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. 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. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. 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. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. PVC Jacket Adhesive: Compatible with PVC jacket.
1. 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. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 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. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 permat 43-mildry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 permat 35-mildry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.

4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 permat 30-mildry film thickness.
   2. Service Temperature Range: Minus 50 to plus 220 deg F.
   3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. Color: White.

2.05 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
   3. Service Temperature Range: 0 to plus 180 deg F.
   4. Color: White.

2.06 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F.
   4. Color: White or gray.
   5. 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).
   6. Sealants 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."

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: White.
   5. 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).
   6. Sealants 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."

2.07 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.08 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd.with a thread count of 10 strands by 10 strands/sq. in.for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd.with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.09 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.10 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. Adhesive: As recommended by jacket material manufacturer.
   2. Color: White.
   3. 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. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inchin width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inchin width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inchin width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inchin width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inchin width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inchin width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches.
   2. Thickness: 3.7 mils.
   3. Adhesion: 100 ounces force/inchin width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inchin width.

2.12 SECUREMENTS

A. Bands:
   1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inchthick, 1/2 inch wide with wing seal or closed seal.
   2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inchthick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inchnickel-copper alloy, 0.062-inchsoft-annealed, stainless steel, 0.062-inchsoft-annealed, galvanized steel.

2.13 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. 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:
   1. 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

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 milsthick and an epoxy finish 5 milsthick if operating in a temperature range between 140 and 300 deg F.Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg Fwith an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install 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 incheso.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches.Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inchesbeyond 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.
4. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inchesbelow 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 07 8413 "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 07 8413 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at 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 inchesover 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.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 incheso.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

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

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

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 INSTALLATION OF MINERAL-FIBER INSULATION

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

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.09 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inchoverlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inchlaps at longitudinal seams and 3-inch-wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inchoverlap 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.

D. Where metal jackets are indicated, install with 2-inchoverlap 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 incheso.c. and at end joints.

3.10 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 9113 "Exterior Painting" and Section 09 9123 "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.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

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 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. 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.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches thick.
      b. Flexible Elastomeric: 3/4 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/2and Larger: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches thick.
      b. Flexible Elastomeric: 1 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2” inch thick.

B. Stormwater and Overflow (Horizontal pipe only):
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches thick.
      b. Flexible Elastomeric: 1 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches thick.
      b. Flexible Elastomeric: 1 inch thick.
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1/2 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.14 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. None.
   2. PVC, Color-Coded by System]: 20 mils thick.
   3. Aluminum, Corrugated: 0.016 inch thick.

3.15 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 22 1116

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Stainless steel piping and fittings.
4. CPVC piping.
5. PEX tube and fittings.
6. Piping joining materials.
7. Encasement for piping.
8. Transition fittings.
9. Dielectric fittings.

B. Related Requirements:
1. Section 22 1113 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.02 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data:
1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.03 INFORMATIONAL SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

C. System purging and disinfecting activities report.

D. Field quality-control reports.

1.04 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 no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.02 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type K, and ASTM B88, Type L.

B. Annealed-Temper Copper Tube: ASTM B88, Type K.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

G. Wrought Copper Unions: ASME B16.22.

H. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
1. Description: Tee formed in copper tube in accordance with ASTM F2014.

2.03 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:
1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:
1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:
1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe:
1. AWWA C151/A21.51.
2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:
1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

F. Compact-Pattern, Push-on-Joint Fittings:
1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

H. Malleable-Iron Unions:
1. ASME B16.39, Class 150.
2. Hexagonal-stock body.
3. Ball-and-socket, metal-to-metal, bronze seating surface.

4. Threaded ends.

I. Flanges: ASME B16.1, Class 125, cast iron.

2.04 STAINLESS STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61 and NSF 372.

B. Stainless Steel Pipe: ASTM A312/A312M, with wall thickness as indicated in "Piping Applications" Article.

C. Stainless Steel Pipe Fittings: ASTM A815/A815M.

D. Appurtenances for Grooved-End, Stainless Steel Pipe:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Anvil International.
   b. Grinnell G-Fire by Johnson Controls Company.
   c. Victaulic Company.
2. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.
3. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:
   a. AWWA C606 for stainless steel-pipe dimensions.
   b. Stainless steel housing sections.
   c. Stainless steel bolts and nuts.
   d. EPDM-rubber gaskets suitable for hot and cold water.
   e. Minimum Pressure Rating:
      1) NPS 8 and Smaller: 600 psig.
      2) NPS 10 and NPS 12: 400 psig.
      3) NPS 14 to NPS 24: 250 psig.

2.05 CPVC PIPING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Charlotte Pipe and Foundry Company.
2. Spears Manufacturing Company.

B. CPVC Pipe: ASTM F441/F441M, type 4120-06 with wall thickness as indicated in "Piping Applications" Article.
1. CPVC Socket Fittings: ASTM F438 for Schedule 40 and ASTM F439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F437, Schedule 80.

C. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.

D. CPVC Tubing System: ASTM D2846/D2846M, SDR 11, tube and socket fittings.

2.06 PEX TUBE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Uponor.
2. Viega LLC.
3. Watts Radiant; A WATTS Brand.
4. Zurn Industries, LLC.

B. Tube Material: PEX plastic according to ASTM F876[**and ASTM F877**].

C. Fittings: ASTM F1960, cold expansion fittings and reinforcing rings.

D. Push-Fit Fittings: ASSE 1061, push-fit fittings.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. SharkBite, A Division of Reliance Worldwide Corporation.
   b. Zurn Industries, LLC.

E. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.07 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 B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

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

2.08 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Form: tube.

2.09 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Cascade Waterworks Mfg. Co.
   b. Jay R. Smith Mfg Co; a division of Morris Group International.

D. Plastic-to-Metal Transition Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Charlotte Pipe and Foundry Company.
   b. Sioux Chief Manufacturing Company, Inc.
   c. Spears Manufacturing Company.
   d. Uponor.
2. Description:
   a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
   b. One end with threaded brass insert and one solvent-cement-socket end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. NIBCO INC.
   b. Spears Manufacturing Company.
2. Description:
   a. CPVC four-part union.
   b. Brass threaded end.
   c. Solvent-cement-joint plastic end.
   d. Rubber O-ring.
   e. Union nut.

2.10 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Matco-Norca.
   b. WATTS.
   c. Wilkins.
   d. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Matco-Norca.
   b. WATTS.
   c. Wilkins.
   d. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Central Plastics Company.
   b. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Grinnell G-Fire by Johnson Controls Company.
   b. Matco-Norca.
   c. Sioux Chief Manufacturing Company, Inc.

d. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 2-1/2 and smaller, shall be the following:
1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, NPS 3 to NPS 8 and larger, shall be one of the following:
1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.

E. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be the following:
1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.

F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
1. Annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

G. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Drawn-temper copper tube, ASTM B88, Type L; copper push-on-joint fittings; and push-on joints.
4. Stainless steel, Schedule 10 pipe; pressure-seal-joint fittings; and pressure-sealed joints.
5. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
6. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints.
7. PEX tube, NPS 1 and smaller.
a. Fittings for PEX tube:
1) ASTM F1960, cold expansion fittings and reinforcing rings.
2) ASSE 1061, push-fit fittings.

H. Aboveground domestic water piping, NPS 2-1/2 to NPS 8, shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

3. Drawn-temper copper tube, ASTM B88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
4. Stainless steel, Schedule 10 pipe; grooved-joint fittings, and grooved joints.
5. CPVC, Schedule 80, type 4120-06; socket fittings; and solvent-cemented joints.

I. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
2. Stainless steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.02 EARTHWORK

A. Comply with requirements in Section 31 2000 "Earth Moving" for excavating, trenching, and backfilling.

3.03 INSTALLATION OF PIPING

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. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105/A21.5.

E. Install valves according to the following:
1. Section 22 0523.12 "Ball Valves for Plumbing Piping."
2. Section 22 0523.13 "Butterfly Valves for Plumbing Piping."
3. Section 22 0523.14 "Check Valves for Plumbing Piping."

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 1119 "Domestic Water Piping Specialties."

G. Install domestic water piping level and plumb.

H. Dead-end domestic supply and circulating water piping shall be no longer than 12” from which the branch or main it is connected to. Provide valved and capped stub-outs for future connections/extensions as shown on the drawings. Stub-outs shall not be longer than 12”.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

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 PEX tubing with loop at each change of direction of more than 90 degrees.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 22 0519 "Meters and Gages for Plumbing Piping."

T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 1123 "Domestic Water Pumps."

U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 0519 "Meters and Gages for Plumbing Piping."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 0518 "Escutcheons for Plumbing Piping."

3.04 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 B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

G. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
   2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
   3. PVC Piping: Join according to ASTM D2855.

J. Joints for PEX Tubing, ASTM: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.

K. Joints for PEX Tubing, ASSE: Join according to ASSE 1061 for push-fit fittings.

L. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.05 INSTALLATION OF TRANSITION FITTINGS

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.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.06 INSTALLATION OF DIELECTRIC FITTINGS

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.

C. Dielectric Fittings for NPS 2-1/2 to NPS 5: Use dielectric flange kits.

3.07 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for copper, ductile iron, and stainless steel tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install vinyl-coated hangers for CPVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install vinyl-coated hangers for PEX tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of copper ductile iron and stainless steel tubing and piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of PEX tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.08 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.09 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 0553 "Identification for Plumbing Piping and Equipment."

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.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
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 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. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
   f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   g. 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.

3.12 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.

B. Clean non-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 procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

SECTION 22 1316

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hub-less, cast-iron soil pipe and fittings.
3. Stainless-steel drainage pipe and fittings.
4. Copper tube and fittings.
5. Specialty pipe fittings.

1.02 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product.

C. Sustainable Design Submittals:

D. Shop Drawings: For hub-less, single-stack drainage system. Include plans, elevations, sections, and details.

1.03 INFORMATIONAL SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Field quality-control reports.

1.04 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Notify Construction Manager 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 Construction Manager's written permission.

1.05 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.01 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.
2. Waste, Force-Main Piping: 100 psig.

2.02 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. 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.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. AB & I Foundry; a part of the McWane family of companies.
   2. Charlotte Pipe and Foundry Company.
   3. NewAge Casting.
   4. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).

C. Gaskets: ASTM C 564, rubber.

D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.04 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. AB & I Foundry; a part of the McWane family of companies.
   2. Charlotte Pipe and Foundry Company.
   3. NewAge Casting.
   4. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. Single-Stack Aerator Fittings: ASME B16.45, hub-less, cast-iron aerator and deaerator drainage fittings.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Conine Manufacturing Co., Inc.

D. CISPI, Hub-less-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company.
      c. Fernco Inc.
      d. Ideal Clamp Products, Inc.
      e. Mission Rubber Company, LLC; a division of MCP Industries.
      f. Tyler Pipe; a subsidiary of McWane Inc.
   2. Standards: ASTM C 1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Heavy-Duty, Hub-less-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. ANACO-Husky.
   2. Standards: ASTM C 1277 and ASTM C 1540.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

F. Cast-Iron, Hub-less Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Charlotte Pipe and Foundry Company.
   2. Standard: ASTM C 1277.
   3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.05 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:
1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.06 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Non-pressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Fernco Inc.
2) Mission Rubber Company, LLC; a division of MCP Industries.
b. Standard: ASTM C 1173.
c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.
e. Sleeve Materials:
1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Shielded, Non-pressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Mission Rubber Company, LLC; a division of MCP Industries.
b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.
4. Pressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Apollo Valves; a part of Aalberts Integrated Piping Systems.

2) Cascade Waterworks Mfg. Co.
3) EBAA Iron, Inc.
4) Jay R. Smith Mfg Co; a division of Morris Group International.

b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Stainless steel.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:
1. Dielectric Unions:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Matco-Norca.
2) WATTS.
3) Wilkins.
4) Zurn Industries, LLC.
b. Description:
1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.
2. Dielectric Flanges:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Matco-Norca.
2) WATTS.
3) Wilkins.
4) Zurn Industries, LLC.
b. Description:
1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig minimum at 180 deg F.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Advance Products & Systems, Inc.
2) Pipeline Seal and Insulator, Inc.
b. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.
4. Dielectric Nipples:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Josam Company.
2) Matco-Norca.
3) Precision Plumbing Products.

4) Victaulic Company.

b. Description:
1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 2000 "Earth Moving."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. 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. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
a. Straight tees, elbows, and crosses may be used on vent lines.
3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install sanitary sewer/storm sewer and vent piping at the following minimum slopes unless otherwise indicated:
   1. Sanitary Waste Piping: 2 percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
   2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. 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.

N. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground PVC piping according to ASTM D 2321.

R. Install engineered soil and waste and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Hub-less, Single-Stack Drainage System: Comply with ASME B16.45 and hub-less, single-stack aerator fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
   4. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

S. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

T. Install force mains at elevations indicated.

U. Plumbing Specialties:
   1. Install backwater valves in sanitary waster gravity-flow piping.
      a. Comply with requirements for backwater valves specified in Section 22 1319 "Sanitary Waste Piping Specialties."
   2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
      a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
      b. Comply with requirements for cleanouts specified in Section 22 1319 "Sanitary Waste Piping Specialties."
   3. Install drains in sanitary waste gravity-flow piping.
      a. Comply with requirements for drains specified in Section 22 1319 "Sanitary Waste Piping Specialties."

V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for sleeves specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs.
   1. Comply with requirements for sleeve seals specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for escutcheons specified in Section 22 0518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hub-less, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hub-less-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
   1. Cut threads full and clean using sharp dies.
   2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
      a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
      b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
      c. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Non-pressure 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.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in ODs.
   2. In Waste Drainage Piping: Shielded, non-pressure transition couplings.
   3. In Aboveground Force Main Piping: Fitting-type transition couplings.
   4. In Underground Force Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.

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

3.05 VALVE INSTALLATION

A. Comply with requirements in Section 22 0523.12 "Ball Valves for Plumbing Piping," Section 22 0523.13 "Butterfly Valves for Plumbing Piping," Section 22 0523.14 "Check Valves for

Plumbing Piping," and Section 22 0523.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.

B. Shutoff Valves:
   1. Install shutoff valve on each sewage pump discharge.
   2. Install gate or full-port ball valve for piping NPS 2 and smaller.
   3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Section 22 1319 "Sanitary Waste Piping Specialties."

3.06 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 0529 "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.

B. Install hangers for cast-iron, stainless-steel, and copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

E. Support vertical runs of cast iron, stainless-steel and, copper soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste 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 waste 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. Install horizontal backwater valves in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves cleanouts, and, drains specified in Section 22 1319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.
   a. Provide shutoff valve if indicated and union for each connection.
   b. 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 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.

3.08 IDENTIFICATION

A. Identify exposed sanitary waste/storm sewer and vent piping.

B. Comply with requirements for identification specified in Section 22 0553 "Identification for Plumbing Piping and Equipment."

3.09 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 waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
   a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
   a. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
   a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
   b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.

c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
   a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
   b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
   c. Air pressure must remain constant without introducing additional air throughout period of inspection.
   d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
      a. Isolate test source and allow to stand for four hours.
      b. Leaks and loss in test pressure constitute defects that must be repaired.
   3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping 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.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hub-less, cast-iron soil pipe and fittings and hub-less, single-stack aerator fittings; CISPI or heavy-duty hub-less-piping couplings; and coupled joints.
   3. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
   4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
   5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   6. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hub-less, cast-iron soil pipe and fittings and hub-less, single-stack aerator fittings; CISPI or heavy-duty hub-less-piping couplings; and coupled joints.
   3. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
   4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   5. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hub-less, cast-iron soil pipe and fittings; CISPI or heavy-duty hub-less-piping couplings; and coupled joints.
   3. Stainless-steel pipe and fittings gaskets, and gasketed joints.
   4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
      a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
   5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   6. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hub-less, cast-iron soil pipe and fittings; CISPI or heavy-duty hub-less-piping couplings; and coupled joints.
   3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
   3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
   2. Schedule 80 PVC pipe; PVC socket fittings; and solvent cement joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
   2. Schedule 80 PVC pipe; PVC socket fittings; and solvent cement joints.
   3. Pressure transition couplings if dissimilar pipe materials.

J. Underground sanitary-sewage force mains shall be any of the following:
   1. Schedule 80 PVC pipe; PVC socket fittings; and solvent cement joints .
   2. Pressure transition couplings if dissimilar pipe materials.

K. Condensate Drainage Piping:
   1. DWV Copper.

END OF SECTION

SECTION 22 1319.13

SANITARY DRAINS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Floor drains.
2. Floor sinks.
3. Trench drains.
4. Channel drainage systems.

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.03 ACTION SUBMITTALS

A. Comply with section 01 3000 – Administrative Requirements for submittal procedures.

B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Refer to scheduled product on drawings.

B. Stainless-Steel Floor Drains, ASME A112.3.1:
1. Refer to scheduled product on drawings.

C. Stainless-Steel Floor Drains, ASME A112.6.3:
1. Refer to scheduled product on drawings.

D. Plastic Floor Drains:
1. Refer to scheduled product on drawings.

2.03 FLOOR SINKS

A. Cast-Iron Floor Sinks:
1. Refer to scheduled product on drawings.

B. Stainless-Steel Floor Sinks, ASME A112.6.7:
1. Refer to scheduled product on drawings.

2.04 TRENCH DRAINS

A. Trench Drains:
   1. Refer to scheduled product on drawings.

2.05 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems, ASME A112.3.1:
   1. Refer to scheduled product on drawings.

B. Stainless-Steel Channel Drainage Systems, Non-ASME A112.3.1:
   1. Refer to scheduled product on drawings.

C. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems:
   1. Refer to scheduled product on drawings.

D. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems:
   1. Refer to scheduled product on drawings.

E. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems:
   1. Refer to scheduled product on drawings.

F. FRP Channel Drainage Systems:
   1. Refer to scheduled product on drawings.

G. HDPE or PE Channel Drainage Systems:
   1. Refer to scheduled product on drawings.

H. PP Channel Drainage Systems:
   1. Refer to scheduled product on drawings.

I. PVC Channel Drainage Systems:
   1. Refer to scheduled product on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. 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.
   3. 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.
   4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
      a. Maintain integrity of waterproof membranes where penetrated.
   5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.
   1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
   1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub 2 inches above floor.

3.02 CONNECTIONS

A. Comply with requirements in Section 22 1316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 22 1319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 22 1323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.03 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 Section 22 0553 "Identification for Plumbing Piping and Equipment."

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Installer Qualifications: All plumbing work at the university shall be performed by a State of Colorado licensed contractor under the supervision of a licensed plumber. Contractors shall verify that plumbers are currently licensed by the State of Colorado and shall supply Project Manager with names and license numbers. Contractors shall have a minimum of 3 years of satisfactory performance in conducting the type of work specified.

B. General
1. Provide a service sink with hot and cold water in mechanical rooms. If a water treatment station is located in the mechanical room, locate the sink within 3 feet, and include a combination emergency eye and body washing station.
2. Provide electric water coolers and drinking fountains at ADA heights. Provide duplex units with heights meeting ADA requirements and normal heights in public areas. Consider heights for children in special areas.
3. Fixtures: Provide battery operated, electronically sensing flush valves, with manual override, on core public area water closets and urinals.
4. See section 23 3200 for general information regarding chemical waste.

C. Backflow Prevention:
1. Provide vacuum breakers or backflow protectors on laboratory fixtures and other fixtures that present a hazard for possible contamination.
2. Review with Design Team, Engineers, EHS and Facilities Management Fluid Group.
3. Arrange water piping systems so back siphoning or backflow into domestic systems is not possible. Consider any water discharging through a faucet to which a hose would be attached potentially hazardous by reason of possible backflow from contaminated areas to which the open end of the hose might be exposed.
4. Install backflow prevention on all laboratory faucets and other points where cross contamination may occur in addition to backflow prevention at building supply.
5. Install backflow preventers on all feed lines to irrigation systems and heating and cooling systems.
6. Install a bypass BFP on the main building service for mains 1” and greater. It shall be sized to meet all critical building loads and be no less than 50% of the primary BFP.

D. Hose Bibs and Wall Hydrants:
1. Provide a minimum of 1 domestic water, freeze-proof wall hydrant, per exterior wall, with loose key type handles at outside locations near entrances to a building for wash down and the University Grounds use. Wall hydrants shall have integral backflow preventers. These should be located as inconspicuously as possible consistent with accessibility. Provide separate shut off valve inside.
2. Provide hose bib with integral backflow preventer at all major equipment locations in mechanical rooms, on roofs and close to cooling towers.

E. Kitchen Grease Traps:
1. Avoid interior locations for kitchen grease traps. If required, provide an engineered unit sized to accommodate area served. Locate grease traps outside for easy truck access and servicing, and properly vented.

F. Underground Tanks and Sumps:
1. Underground storage tanks are not permitted without approval of the University Project Manager.
2. Tanks shall be installed by contractors licensed by the State Oil Inspector.

3. Advance permits from State Oil Inspector are required prior to installation, repair, upgrade, removal or abandonment.
4. Notification forms (EPA) shall be sent to State Health Department and State Oil Inspector upon completion of installation of new tanks.

G. Fuel Tanks (Above Ground):
1. Shall conform to NFPA 30, 31, 54 and 50A (Hydrogen), OSHA 29CFR1910.106, 29CFR1910.110 (LPG) and 29CFR1910.153, NFPA 395 (farm), NFPA 58 (LPG) and UFC Article 79, 80 and 81 (LPG).

H. Domestic Hot Water Heaters: Where steam is available, provide an instantaneous steam heat exchanger. Gas fired, or small electric heaters are acceptable with approval of University Project Manager. See also section 23 5700.

I. Roof Drain Overflow: Overflow drains shall not drain on to sidewalks or areas where water or ice could present a hazard or nuisance.

J. Janitorial Closets:
1. Provide Mop Service Basin. Mop Basin to be constructed of monolithic preformed basin material with stainless steel sill.
2. Mop Basin faucet type to be a/b/e specialty mop sink with pail hook and wall brace.
3. All plumbing connections to be ½ mnps thread.

K. Water meters: See section 23 0900.

1.2 QUALITY ASSURANCE

A. Codes and Standards:
1. Meet the requirements of International Plumbing Code.
2. Meet the requirements of national laws regarding ADA accessibility, energy and water conservation.
3. All valves, fixtures and accessories in contact with domestic water shall meet the requirements of NSF/ANSI Standard 61.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Lavatories, Sinks, Service Sinks, Mop Service Basin, Water Closets, Urinals:
a. American Standard U.S. Plumbing Products
b. Crane Co.
c. Kohler Co.
d. Eljer
2. Stainless Steel Sinks:
a. Elkay Mfg. Co.
b. Just Mfg. Co.
c. Moen; Div. Of Stanadyne
d. Eljer
3. Molded Tubs and Shower Units:
a. Fiat Products
b. Kohler Co.
c. Eljer
4. Faucets:
a. Chicago Faucet Co. (preferred)

b. American Standard; U.S. Plumbing Products
c. Zurn

5. Auto Faucets
   a. Sloan Valve Co (preferred)
   b. Zurn
6. Flush Valves:
   a. Sloan Valve Co. (preferred)
   b. Zurn
7. Auto Flush Valves
   a. Sloan Valve Co (preferred)
   b. Zurn
8. Water Closet Seats:
   a. Bemis Mfg. Co.
   b. Beneke Corp.
   c. Olsonite Corp
9. Water Coolers:
   a. Elkay
   b. Halsey Taylor Div.
   c. Haws Drinking Faucet Co.
10. Fixture Supports:
    a. JR Smith
    b. Zurn
11. Shower and Tub Trim (Thermostatic):
    a. Bradley
    b. Powers
    c. Speakman
12. Shower and Tub Trim:
    a. American Standard
    b. Kohler
    c. Chicago Faucets
13. Emergency Showers, And Eye/Face Washes:
    a. Guardian Equipment
    b. Haws Drinking Faucet Co.
    c. Bradley
14. Food Waste Disposers:
    a. In-Sink-Erator
    b. Waste King
    c. National
15. Hose Bibs and Faucets:
    a. Zurn
    b. Woodford
    c. Watts Regulator Co.
16. Venturi Flow Measuring Elements:
    a. FDI (preferred)
    b. HCI
    c. Gerand
17. Calibrated Balancing Valves:
    a. FDI (preferred).
    b. HCI
    c. Gerand
18. Automatic Balancing Valves
    a. FDI (preferred)
    b. Griswold
19. Wall and Yard Hydrants:
    a. Josam Mfg. Co.

b. Jay R Smith Mfg. Co.
c. Woodford Mfg. Co.

20. Water Hammer Arresters:
    a. Woodford
    b. J.R. Smith Mfg. Co.
    c. Watts Regulator Co.
21. Instantaneous Steam-Water Heaters:
    a. Leslie (preferred)
    b. Spirax Sarco
    c. Grahm
22. Backflow Preventer Equipment:
    a. Watts Regulator Co. (Preferred)
    b. Febco Sales
    c. Wilkins

2.2 MATERIALS, GENERAL

A. Fixtures and Trim:
1. All vitreous fixtures shall be of a quality commercially known as 'Twice-Fired Vitreous China'.
2. All enameled ware shall be cast-iron with 'Acid-Resisting Enamel'.
3. Reference 11 53 00 for Laboratory Fixtures.
4. Water Closets: Wall mounted or wall-hung type. Floor mounted fixtures permitted on a special need basis. Tank type fixtures are not allowed.
    a. General: White, vitreous china, water saving siphon jet, elongated rim, wall-hung water closet.
    b. Coordinate the flush valve rates with the University Project Manager.
    c. Miscellaneous Requirements or Accessories:
        1) Seat: White plastic, open front seat less cover, with self sustaining check hinge. Seat shall have an antimicrobial compound as an integral part of the plastic and shall match shape of bowl.
        2) Flush valves: Chrome plated valve with vacuum breaker and 1-inch screwdriver stop with vandal resistant protective cap and adjustable tail piece.
        3) Carrier: Commercial carrier with adjustable face plate and fittings.
        4) Flush valve: Chrome plated valve with vacuum breaker, 1-inch screwdriver angle stop with vandal resistant protective cap and adjustable tailpiece. Limited to dual flush 1.1/1.6 gallons per flushing cycle.
5. Urinals:
    a. General: White, vitreous china, siphon jet urinal with integral extended shields, flushing rim.
    b. Coordinate the flush valve rates with the University Project Manager
    c. Miscellaneous Requirements or Accessories:
        1) Carrier: Commercial carrier with top and bottom plates.
        2) Flush valve: Chrome plated valve with vacuum breaker, 1-inch screwdriver angle stop with vandal resistant protective cap and adjustable tailpiece. Limited to 1.0 gallon per flushing cycle.
6. Lavatories:
    a. General:
        1) Vitreous china, self-rimming counter top 20" x 17" lavatory.
        2) Vitreous china, self-rimming wall hung 20" x 18" lavatory with back splash.
7. Stainless Steel Sinks: 18 gauge 304 stainless, self-rimming, single or double compartment sink.
8. Showers:
    a. Fiberglass: Reinforced plastic shower stall with integral molded base and 2 inch drain fitting and chrome plated strainer. Provide with additional reinforcement for grab bars.
    b. Terrazzo: Precast terrazzo shower floor with single threshold and 2 inch integrally cast stainless steel drain with removable stainless steel strainer.

9. Utility Sink: Acid resistant, enameled cast iron, wall mounted high back sink with wall hangers and stainless steel rim guard; 3 inch cast iron P-trap with enameled interior, painted exterior, floor bracket and chrome plated brass sink strainer with open grid drain.
10. Mop Service Basin: Precast terrazzo, service basin with 3 inch integrally cast brass or stainless steel drain with removable strainer. Provide stainless steel guards on all sides.
11. Emergency Eye Wash: Wall mounted, vitreous china or stainless steel receptor with mounting bracket, twin chrome plated heads angled to direct water flow into eyes and ocular face area. Provide flag push-type ball valve to stay open until manually closed. Water delivered by Eye Wash shall be tepid (lukewarm). Installation shall meet or exceed the provisions of ANSI Z358.1 (latest version).
12. Emergency Shower: Ceiling mounted, 10 inch diameter deluge shower head. Rigid triangular pull-rod to actuate instant-action stay-open ball valve. Water delivered by the Emergency Shower shall be tepid (lukewarm).Installation shall meet or exceed the provisions of ANSI Z358.1(latest version).
13. Combination Emergency Shower and Eye Wash: Floor mounted, free standing, all chrome plated brass construction with 10 inch diameter deluge shower head and eye wash bowl. Shower shall have rigid pull rod to actuate instant-action stay open ball valve. Eye wash shall have twin anti-squirt heads angled to direct water flow into eyes and ocular face area with flag push-type ball valve actuator, valve to stay open until manually closed. Water delivered by the Emergency Shower and Eye Wash shall be tepid (lukewarm).Installation shall meet or exceed the provisions of ANSI Z358.1(latest version).

B. Water Coolers:
1. Self-contained, wall mounted, stainless steel, mechanically cooled, drinking fountain. Minimum cooling capacity of 8 gallons per hour of 50 degree F drinking water at the inlet water and room ambient temperatures of 80 degree F with adjustable water temperature control. Equip drinking fountains with handicapped fittings. Care shall be taken to specify fountains with basins and spouts to minimize dripping, etc. on floor. Provide with commercial carrier.

C. Trap Primers: Bronze body valve with automatic vacuum break and 1/2-inch connection to domestic water. Operation shall be by time clock initiation of electric solenoid valve.
1. Neoprene sleeve trap guards are not acceptable
2. Pressure differential style primers are not acceptable.

D. Automatic Flow Control Valves (Flow Limiting Devices)
1. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified amount.
2. For 1/2" - 2", the flow cartridge shall be removable from the Y- body housing without the use of special tools to provide access for regulator change-out, inspection and cleaning without breaking the main piping. (Access shall be similar to that provided for removal of a Y-strainer screen).
3. The maximum pump head for the automatic flow control valve shall be limited to 7 feet.
4. Each valve shall have two P/T ports.
5. All automatic flow control devices shall be supplied by a single source and certified flow tests, witnessed by a professional engineer, shall be available.
6. Five year product warranty and free first year cartridge exchange.

E. Manual Calibrated Flow Control Valves
1. Manual balancing devices shall be venturi type as recommended by ASHRAE.
2. Devices shall have a precision formed throat and have a stated catalog accuracy of 3% F.S.
3. The induced differential reading (flow signal) shall be greater than two feet water column at the design flow with the valve in the wide open position.
4. The permanent pressure loss at design flow shall not exceed two feet of water in the wide-open position.
5. The valves are to have differential readout ports fitted with check valve and protective cap, and are to have a memory stop to allow complete shut-off and return to set position without losing the set-

point.

F. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. All exposed piping serving plumbing fixtures that may be used for ADA purposes shall have traps and supplies insulated per ADA requirements.

B. Install flushing mechanism for both ADA accessible flush valves and flush tanks to the side of water closet that has the most floor space per ADA requirements.

C. Provide a tempering valve that conforms to ASSE 1070 for all lavatories and sinks used as a public hand wash facility.

3.2 TESTING, CLEANING, AND CERTIFICATION

A. Provide copies of State backflow preventer certification tests.

B. Adjusting: After cleaning and flushing operations are accomplished, adjust flush valves, faucets, showers, bubblers for proper flow.

END OF SECTION 22 30 00

SECTION 23 00 00 – PLUMBING, HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

PART 1 - GENERAL

1.1 REFERENCES

A. Manual Part 3, Project Planning and Design Guidelines and Standards

B. Drawing and General Provisions of Contract, including General and Supplementary General Conditions and Division 1 section apply to work in Division 23.

C. Codes and Standards: Reference Architect's agreement. Include referenced codes and standards in Contract specifications.

1.2 SYSTEM DESIGN REQUIREMENTS

A. The University Philosophy:
1. The university is extremely conscious of maintenance costs. Give special attention in the design process to provide for sufficient and safe access space for maintenance of mechanical systems. Clearly indicate locations of ceiling and wall access panels and other necessary access space. Provide easy access to rooftop equipment.
2. Exterior mechanical installations must not only be designed for proper functions, but must be considered in the aesthetics of building design. Locate large and unsightly installations hidden from public view and enclose appropriately.
3. Show mechanical installations on drawing elevations of structures including, installations projecting above parapet walls.
4. Design systems to provide flexibility in the future. Provide systems that are easily adaptable to new layouts or changes in use. Layout mechanical rooms with space for future equipment. Study the possibility of future needs, expansion, or new equipment at the time the basic design is being formulated.
5. The university is committed to sustainable, low energy use and environmentally friendly buildings. Apply LEED and High Performance Buildings into design and construction.

B. Certain operations require special HVAC systems consisting of filtration, humidity control, special exhaust systems, or different temperature settings than surrounding spaces. These areas may include, autoclaves, lab equipment, print shop equipment, machine shop equipment, carpentry shop equipment, metal working shops, and laboratories involved in higher level chemical, biological, and radioactive material experimentation. Work with the University Project Manager to identify these areas and determine appropriate design parameters.

C. Notify the University Project Manager of all modifications affecting supply and exhaust air in animal rooms, laboratories, environmental chambers, confined spaces, trailers, office spaces, darkrooms, and buildings or spaces being renovated or modified for special occupancies.

D. Obtain a complete list of the chemicals and gases to be used and stored in laboratories. Use this list to determine fume hood exhaust for flammability, toxicity, corrosiveness, and explosion hazards.

E. If perchloric acid is used, provide a specialized, dedicated hood constructed of stainless steel, porcelain coated, or non-plasticized PVC lined. Label hood "for perchloric acid use only". Provide the hood with its own non-reactive duct and exhaust fan and built-in water wash-down system.

F. Provide galvanized steel, aluminum, PVC coated, or stainless steel ducts for ventilating bio safety cabinets, chemical fume hoods and flammable storage cabinets. Design and install systems to ensure that hoods and ducts are under negative pressure all the way out of the building.

G. If a hood is tied into an existing central exhaust system serving multiple fume hoods, then the air system will need to be evaluated to determine if it has sufficient capacity for the addition of other exhausted equipment.

H. Provide make-up air to compensate for the air being exhausted. The location and volume of make-up air is critical to assuring proper fume hood operation and worker protection.

I. Air Handling Devices
1. Base calculations on methods and data from the most recent issues of ASHRAE, Fundamentals Handbook.
2. AIHA/ANSI standards shall be utilized for projects with .laboratory or industrial ventilation requirements.
3. All AHUs and exhaust fans shall be AMCA certified for sound and air performance
4. Design air conditioning systems to conserve energy. Systems shall automatically adjust to actual space load conditions to reduce energy consumption at part loads. The use of fan powered terminals and fan coil units are discouraged, and any use of these products must be approved by Building Maintenance and Operations through the University Project Manager.
5. Use the following design temperatures for heating and air conditioning systems:
   a. Winter:
      1) Outside air temperature: -10 degree F. outside air temperature. For 100 percent outside air systems use -20 degree F.
      2) Inside air temperature: 72 degree F.
      3) Wind velocity: 15 mph.
   b. Summer:
      1) Outside air temperature: 100 degree F. dry bulb, 59 Degree F. wet bulb for systems with OSA economizers or 100% OSA Systems, otherwise 95/63.
      2) Inside air temperature: 72 degree F dry bulb, 63 degree F wet bulb.
      3) Air cooled condensers and dry coolers: 105 degree F.
      4) Wind velocity: 8 mph.
   c. Discuss laboratory, animal holding and other special room requirements with the University Project Manager.
6. Ventilation: Comply with ASHRAE 62 Ventilation Standards. Provide demand control ventilation in highly occupied spaces. Laboratory spaces to comply with ANSI Z9.5.
7. Pressurization: All specified pressure differentials are with respect to the adjacent corridor.

Ante Room (or lab without ante room)	Negative	0.01 (In. H2O)
Laboratory (BSL-2)	Negative	0.01 (In. H2O)
Laboratory (BSL-3)	Negative	0.05 (In. H20)
Office	Positive	0.01 (In. H2O)

Classroom	Positive	0.01 (In. H2O)

Verify pressurization requirements with the university project manager

8. Engineer to indicate pressurization relationships, and specify individual CFM offsets for spaces on the drawings.
9. All research and academic laboratories should be designed with negative pressure, inward air flow. Any deviation from that standard would require a completion and approval by EH&S.
10. Locate the supply, return, and/or exhaust in a given space so flow of air will be toward the most contaminated area of that space.
11. Do not provide humidity control except when specifically required by the program plan. When humidity control is necessary use plant steam to generate clean steam through a clean steam generator.
12. Use outside air for cooling whenever economical. Where practical design systems with economizer cycles that automatically allow the quantity of outside air supplied to the building to be modulated.
13. Use transfer fans for cooling for electrical closets where possible except for large main electrical rooms. Do not provide fan coils in secondary electrical closets.
14. Filter loading design pressure drops:
    a. Pre-filters = 0.9 IN WC
    b. Final-filters = 1.5 IN WC
    c. HEPA filters = 1.5 IN WC
15. Locate air handling equipment inside buildings.
16. Discuss the needs for redundant (2N, where N = the number of devices required to meet the load,) and back up (N+1, where N = the number of devices required to meet the load) systems with the UC Project Manager. On mission critical applications, determine the system's single point of failure(s).

J. Design systems that require 24 hours/day operation separate from those that may require only 8 hours/day operation. Systems that require 8 hours/day of operation shall be zoned appropriately for unoccupied operation.
1. Equipment cooling with domestic water is prohibited. Cooling loads should be supplied chilled water from the campus district chilled water system. Requests for exemption shall be made to the University Project Manager.
2. Unless otherwise specified, isolate all rotating and reciprocating machines so that 90% of the disturbing frequency shall be eliminated.
3. The university utilizes a central Building Automation System (BAS) for control of HVAC functions. Coordinate HVAC tie-ins with the BAS.
4. Avoid small separate heating and cooling devices such as fan coil units and unit heaters except for energy conservation or to facilitate scheduling of air handlers. Where this equipment is used, it shall be controlled by the BAS.
5. Provide occupied-unoccupied programming of systems to initiate shut down of ventilation, exhaust, fan systems, and pumps wherever possible.
6. Use variable air volume supply and exhaust to compensate for diversities in loads and reduce equipment sizes.
7. Water-cooled or air cooled condensers are acceptable depending upon job requirements. Water-type cooling towers are preferred to conserve energy and should be considered on systems 80 tons and larger.
8. Specify electrical by-pass switch, external to the drive at critical locations, with appropriate safeties on variable speed controllers to allow use of the equipment if the variable speed controller fails.
9. Design systems utilizing campus district steam and chilled water.
10. Hydraulically decouple the building pumped systems from Utility Company and/or campus district systems. Reference Part 3 for Steam and Chilled Water Utility Connection standards.
11. Design hydronic systems with two-way valves.
12. Chilled Water Systems: Design chilled water systems with a 14 degree temperature difference. Design buildings with variable flow pumping systems
13. Thermostat Locations: Locate thermostats central to the load and where possible near the door.

Mount thermostats 60 inches above finished floor except mount adjustable thermostats in accordance with ADA requirements.

14. For remodel projects, note for demolition of existing piping to the main riser. Demolition of an existing piping system will include removal of components which do not remain as part of the system, all associated abandoned hangers, valves, supports, and all associated equipment.
15. Verify the use of return air plenums with the University Project manager. Where plenums are allowed, all return air grills shall be provided with return air boots.

K. Laboratories - General:
1. Select exhaust fans in a common system to be capable of providing 30 percent extra capacity and pressure. The speed increase shall not exceed the safe recommended speed as specified by the manufacturer of the device.
2. Provide laboratory with 100% exhaust.
3. Where surrounding structures, building air intakes, public gathering places, or other areas may pocket or concentrate chemical exhaust contaminants from the exhaust systems, then the exhaust shall be treated to minimize point source air contamination by using a high plume dilution exhaust fan.
4. Locate laboratory supply air grilles to prevent unwanted cross drafts around specialty equipment such as chemical fume hoods, biosafety cabinets, and atomic absorption spectrophotometers. Airflow shall move from the entrance of the lab towards the lab hood.
5. Maintain lab and entry vestibule under negative pressure.
6. Maintain the lab more negative than the vestibule.
7. Equip hoods with audible and adjustable visual low-flow alarm set to alarm at face velocity as determined by the manufacturer and acceptable with EH&S..
8. Provide redundant/backup HVAC systems for air handlers and exhaust fans serving laboratories.
9. Fume hoods to be VAV.
10. Provide emergency backup power on hazardous exhaust systems and do not shut down upon activation of any alarm. Provide dedicated switches in the building fire alarm panel to allow capability for manual fan shutdown by the fire department.
11. Air change rates in laboratory spaces to turn down based on occupancy. Verify air change rate with the university project manager.
12. For flammable storage cabinets, do not exhaust. If exhaust is deemed necessary, confirm with EHS and AHJ and provide fire damper. Verify exhaust system can accommodate flammable airstream.
13. Provide heat recovery systems on laboratory systems when possible.
14. Coordinate minimum air change rates with the University Project Manager and EH&S.
15. Mount sash sensors outside fume hoods on corrosive chemical applications.
16. The need for a push-button timed over-ride on fume hood sash alarms shall be approved by the University Project Manager and EH&S
17. Ventilate Chemical Storage Rooms or Waste Storage Rooms.

L. Laboratory HVAC Control: The laboratory control system shall perform the following functions:
1. Hood face velocity
2. Laboratory pressurization
3. Laboratory temperature control
4. Proper air distribution
5. Pressurization (either positive or negative) shall be maintained by airflow based on the formula:
    a. Supply cfm: Exhaust cfm - offset cfm.
    b. Supply cfm: Air supplied to the space to maintain temperature and provide make-up.
    c. Exhaust cfm: Air leaving the space either through the hood’s exhaust or through the general exhaust.
    d. Offset: Is an arbitrary amount set to provide pressurization.
6. The lab controller (programmable) shall receive inputs from all controlling devices and provide outputs to control the lab’s environment.

M. Standard Laboratories - Biosafety Level 2:
1. Provide 30% reserve capacity in new HVAC systems design to accommodate future research needs and help retard system obsolescence and minimize overall capital outlay.
2. Laboratory air circulation shall comply with ASHRAE standards.
3. Maintain all laboratories under negative pressure.
4. Design laboratory exhaust air grilles with inflow air velocity rates ranging between 500 and 700 linear feet per minute.

N. Standard Laboratories - Biosafety Level 3 (BL3):
1. Design in accordance with the Campus standard “Biosafety Level (BL3) Construction Standards. Copies of this standard are available from the university EH&S.
2. All supply and exhaust from each holding room must be provided with bubble tight control dampers.

O. Photography Darkroom: The Kodak K-13 photo darkroom design standard shall be used as a guide. All photo darkroom designs shall be specified and/or approved by the university DEHS before any implementation. Minimum requirements to control photochemical vapors, fumes, and dusts are as follows:
1. All darkrooms shall have 100% outside air supply. Exhaust shall be discharged away from any building air intake. Provide a minimum of 8 air changes per hour. Maintain all darkrooms at a negative pressure to its surroundings (0.05 in wg.).
2. Desired and compatible temperature ranges for photo darkrooms shall be 69 to 75 degree F.
3. The university DEHS will participate in photo darkroom design, as there may be special requirements associated with numerous processes that generate hazardous gases and shall approve all plans before any construction takes place.

P. Environmental Chambers: These units are variable and shall be evaluated individually by the university DEHS before purchase and/or installation.

Q. Biosafety Cabinets (BSC):
1. Construction of new facilities in campus may require the installation of biosafety cabinets. Some BSCs of the Class II Type B 2 have 100% exhaust requirements. Design of space HVAC systems shall accommodate the exhaust requirements of the BSCs. In addition, filter pressure drops across HEPA filters must be monitored for proper system airflows.

R. Equip multiple hoods on the same fan system with a control damper at each hood

S. Animal Facility Design Conditions:
1. Heat and ventilate animal laboratory and animal facilities by an independent system.
2. Conform to the most current edition of the ILAR "Guide for Care and Use of Laboratory Animals", available from the University Project Manager and/or Institutional Veterinarian.
3. Additional guidelines and design criteria for animal holding areas may be applicable. The University Project Manager shall coordinate with the Institutional Veterinarian for additional guidelines.
4. Provide separate ventilation system for the animal facility and system redundancy and system monitoring. Redundant systems required for supply, exhaust, heating and cooling so minimum environmental conditions can be maintained in animal holding with one unit out of service. Discus requirements with Institutional Veterinarian and the University Project Manager.
5. Size strainers on floor drains to match the size of sewage material from the animal facilities. The University Project Manager shall coordinate with animal facility personnel.
6. All wall and ceiling penetrations (including fire sprinkler heads) to be sealed airtight for vermin control.
7. Provide dedicated exhaust system for the cage wash area due to saturated vapor content. Exhaust duct should be stainless steel.
8. Provide 100% outside air with MERV 15 filtration.

9. All ductwork in animal facilities must be welded stainless steel.
10. All supply and exhaust from each animal hold room must be provided with bubble tight control damper. These dampers are controlled individually thru the BAS for decontamination purposes. Coordinate decontamination requirements with the University Project Manager.
11. Temperature and Humidity criteria: Maintain temp set points +/- 2 deg between 64-84 deg F. Humidity must be maintained between 30-70% with +/- range of 10% RH (with the low not allowed to go below 30% or high above70%). Depending on species, there may be rooms that require temp and humidity levels outside of range. Discus requirements with Institutional Veterinarian and the University Project Manager
12. All facility systems should be on back-up generator
13. Locate distribution systems in full accessible interstitial space with a minimum of 6' 8" clear height. All serviceable components should be accessible.
14. Mechanical systems should be soundproof to minimize disturbance to research animals. Systems should not be located directly above or adjacent to animal holding rooms.
15. Facility should have the following through a central distribution system:
    a. Medical O2 (NFPA 99 certified)
    b. CO2
    c. Vacuum.
16. Animal Watering System:
    a. An automatic watering system to all animal housing rooms.
    b. Water is RO with acidification.
    c. Automatic watering system is flow thru or filtered recirculation system.
    d. Stainless steel manifold distribution designed in a way to prevent "dead legs."
    e. System shall be equipped with a programmable flush system for each rack and be centrally monitored for pressure or leaks.
    f. System should be designed to include treated storage tanks that are sized accordingly to provide minimum of 48hours of animal drinking water (when facility is at full capacity) in an emergency.
    g. BAS shall monitor system
    h. See 23 60 00.

T. Utilities:
1. In general, utilities will be included in Division 2 and work in this Division will only extend to 5 feet outside of Building or Structure excavation perimeter.
2. Specify the following where exceptions occur and Building Services extensions and connections are made to public utilities:
    a. Connection charges, membership fees, system development charges, and the like, that in principle allow the right to obtain a services from a Utility Company will be arranged and paid for by the university.
    b. In the event that the serving Utility Company installs their own taps, service, meters, etc., all costs imposed by this action shall be the responsibility of the Contractor.
3. The Campus is a continuously operating facility. Construction of new and maintenance of existing utility systems, equipment and distribution requires capability of isolation of equipment, systems, and branches of the distribution system. It is therefore imperative that the design and installation of new and modified utility systems include sufficient isolation capability. All work involving the central utility systems (i.e., steam, natural gas, condensate, chilled water, hot water, domestic water, medical gases, and/or vacuum systems), whether upgrade of the system or tie-in to the central system must include provisions for system isolation. Location of isolation devices shall comply with the directives in Section 01040. An isolation plan shall be submitted to the University Project Manager as part of the Schematic Design and Construction Document phases of the project. The University Project Manager will be responsible for approval of the plan and coordination with the Design Team.
4. The University Project Manager will furnish information regarding the preferred locations of incoming utility services to the building and waste outlets. This will generally be furnished in the form of a site plan and pertinent elevations will be given. Piping in the building must be generally arranged and oriented to conform to these. Layouts should not be started until this information has

been furnished.

5. All incoming utilities shall be metered. Meter domestic water per Local standards and meter chilled water, electricity and steam per the university standards, which are available through the University Project Manager. Provide for isolation of meter, bypass around meter, and complete shutoff of meter and bypass.
6. All incoming utilities shall be provided with means of isolating the building from the utility distribution system inside the building at the point where the utility enters the building.
7. The University Project Manager will furnish the locations of all underground utilities prior to demolition and excavation.
8. Steam is distributed from the university Central Utility Plant via direct buried lines. Nominal distribution pressure is 125 psig saturated. All building mains shall be dripped and branches back-graded to the main.
9. Install steam service lines to each building with a minimum of 20 pipe diameters straight run for metering.
10. Provide main building shut off valves outside the building typically in the mechanical vault.
11. Insulate all steam and condensate lines. Insulate valves, strainers, and other equipment with removable preformed insulated casings or jackets.
12. Steam condensate is returned to the university Central Utility Plant via direct buried lines.
13. Condensate receivers with mechanical pumps are not permitted without approval by the university Facility Operations through the University Project Manager. If pumps are used, provide centrifugal duplex type with cast iron receiver. Provide float operated mechanical alternator for switching for alternate service. Size receiver capacity for 25% future capacity. Install flash tanks ahead of receivers.
14. Specify methods and locations of trapping.
15. Meter steam supply in each building. Steam and condensate meters must be approved by the university Facility Operations through the University Project Manager.

U. Steam and Condensate Distribution Systems:

1. Campus steam is provided by connecting to the piping headers located inside the designated mechanical utility vault. The utility vaults house the expansion joints and condensate trapping stations for the steam service. All penetrations into the utility vaults shall be constructed such that the watertight seal at the wall is maintained. These header connections are typically 12” Sch 40 steel pipe. Saturated steam at 110-125 psig will be provided for the building at the steam header.
2. Steam Distribution Piping:
    a. An isolation valve must be located in the utility vault downstream of the connection to the steam header. The service pipe from the utility vault to the building shall be according to the standard specification for preinsulated piping systems. The service pipe from the vault to the building shall be anchored in un-excavated soil within 5 feet outside of the vault wall and also outside the building wall in order to minimize the expansion directed into the vault and building. Provision for thermal expansion of the service line must be addressed. Additional expansion loops and anchors may be required depending on the distance and routing. Extreme care should be taken in the design of the high temperature piping systems to avoid excessive stress on the pipe, anchors, vault and building. The slope of the steam connection piping must lie so that the condensate is effectively drained to either the steam header located in the utility vault or to the building.
    b. After the building penetration, isolation flanges and gaskets should be provided to electrically isolate the distribution system from the building in order to prevent electrolytic corrosion on both systems (see REF DWG 1). Provisions to trap the condensate must be made directly after the isolation flanges and gaskets in the building. Downstream of the trapping station an isolation valve must be located inside the building. Directly downstream of the isolation valve and upstream of the building pressure reducing station, a vortex-shedding mass flow meter, pressure and temperature compensating, shall be installed (see specification). This meter will be installed in a length of straight pipe dictated by the particular piping configuration and model of steam meter in order to have accurate measurement. The meter shall be sized to accommodate both the maximum and the minimum flow rates anticipated. If the metering accuracy cannot be maintained at both

the maximum and minimum flow values of the meter, a parallel dual meter installation will be needed. If necessary, the combination of two meters must be sufficient to measure low load conditions. The meter output shall report to the Building Automation System (BAS) and communicate with the campus network. Meters may need periodic calibration based on the manufacturer's recommendation.

3. Steam Meter Specification: Please see section 23 09 00
4. Steam Condensate:
   a. Condensate return is done by connecting to the headers located inside the mechanical utility vault. These header connections are typically 4" Sch 80 steel pipe.
   b. An isolation valve must be located in the utility vault upstream of the condensate header and header isolation valve. The service pipe from the utility vault to the building shall be according to the standard specification for preinsulated piping systems. The service pipe must be anchored in un-excavated soil within 5 feet of the vault wall and also outside of the building wall in order to minimize the expansion directed into the vault and building. Thermal expansion of the service line must be provided for outside of the utility vault, between the anchors.
5. Draining Piping Low Points:
   a. If it is necessary to trap and drain the connection line in-between the utility vault and the building, and no practical steam main drainage scheme exists, using only pipe slope (either to the building or to the utility vault), then these traps may be connected directly to the pumped condensate return line. Care must be taken in sizing the steam main from the vault to the building because if the building penetration is located higher than the utility vault connection, and it is desired to drain the condensate into the utility vault, over-sizing the steam main to accommodate counter flow conditions may be necessary.
   b. Upstream of the building penetration, isolation flanges and gaskets should be provided to electrically isolate the distribution system from the building in order to prevent electrolytic corrosion on both systems. Upstream of the isolation flanges there is located a single trap discharge connection from the steam trap located upstream from the steam isolation valve located inside the building. A steam condensate isolation valve shall be located inside the building upstream of the trap discharge connection.
6. Liquid Mover:
   a. The steam condensate return system is intended to operate in the future under pressure and have no working atmospheric vents after leaving the buildings. All condensate trapped inside the building must be collected in a non-vented receiver and pumped into the condensate return system using a steam motivated steam condensate pump (see REF DWG 1). Please note that the pressure reducing valves serving the steam condensate pumps are fed with the pressure of the main steam line (110-125 psig) upstream of any pressure reducing stations. This allows the motivation pressure of the steam-powered pumps to be adjusted over time to meet the changing system demands without concern regarding the pressure of the steam for use by the building loads.
   b. It is anticipated that the condensate return line back-pressure will increase as more buildings are constructed and come on line. Building condensate return design should be based on the worst case of 35 psig back pressure, yet be adjustable for the low backpressure that will be seen during the first several years.
7. Condensate Return Temperature:
   a. Minimum steam condensate return temperature from the building is assumed to be 180F. Maximum steam condensate return temperature from the building is assumed to be 200F. Under no circumstance is live steam (other than flash steam) to be introduced into the steam condensate return lines.
   b. Damage may occur to the insulation and waterproof protective jacketing if excessive pipe surface temperatures are reached. This damage will lower the long-term efficiency and will shorten the service life of the piping system.

V. Chilled Water Distribution Systems
1. The Central Utility Plant (CUP) produces chilled water at 40F and through a variable flow primary distribution system, provides chilled water to the buildings for cooling. There is an assumed heat

pickup during distribution of less than 1F.

2. CUP Chilled Water Re-set Schedule:
   a. Building design should reflect an increased chilled water supply temperature during cold outside conditions. CUP provided chilled water supply temperature will increase during cold weather as shown in the schedule.
      1) If OSA > 45 F, then building design at CHWS = 41F (standard condition)
      2) If OSA < 45 F, then building design at CHWS = 46F (free cooling mode)
   b. Chilled water should be returned to the CUP at 56F.
3. Chilled Water Connection Configuration:
   a. The campus chilled water distribution system will operate in a de-coupled manner. A primary-secondary bridle connection and building circulation pumps should be used for building cooling. The CUP provision of chilled water uses variable-flow primary pumping to the building infrastructure connection.
   b. Campus buildings use internal secondary loops with variable flow pumping to distribute chilled water to the HVAC (Heating, Ventilation, and Air-Conditioning) and process cooling loads (typically process loads are isolated in a tertiary pumping loop using a heat exchanger).
   c. The primary-secondary pumping interface is an important consideration. Use of a 2-way modulating control valve installed on the return leg back to the CUP is used to maintain a chilled water return of 56F (see REF DWG 2).
4. Low Delta T Syndrome:
   a. The CUP is design to accept 56F chilled water return (CHWR) and maintaining this full temperature differential has energy utilization advantages.
   b. The energy cost associated with a low delta T can be avoided, but requires that building designers exercise care both in design and commissioning of their respective building projects.
   c. An important consideration is the ability of the building to maintain 56F chilled water return back to the CUP – especially at peak load, but also at part load. As the standard suggestions, using a 2-way control valve to hold building return chilled water at 56F, before allowing it to return back to the CUP, can cause building cooling problems. Building designers need to exercise great caution in considering the potential for chilled water mixing in the de-coupling bypass pipe. The commissioning process should be used to verify high CHWR temperatures leaving individual heat transfer devices within the building, in a dynamic setting, at both peak load, and at part load. Relaxing the requirement of CHWR = 56F will not be a solution to poorly controlled building loads. It is important to consider the matching of flows for building pumping with chilled water demand at the various building loads. Flow meters will be used on both the primary loop and the secondary loop to facilitate Building Automation System (BAS) control logic to approximate flow matching.
5. Special Consideration of CHWR < 56F:
   a. The university accepts, with respect to HVAC loads, that there are certain coil entering air conditions, depending on AHU (air handling unit) design, that will not allow chilled water leaving the coil to reach 56F.
   b. These special circumstances must be identified and approved on an individual building/project basis. Often this is discussed with reference to outside air conditions (OSA), though the range where the OSA temperature impacts specific designs, and consequently the requirement to hold CHWR = 56F, will differ based on the project. For the most part, this difficult operating range covers a small period of time.
   c. This standard is not intended to require a fixed unyielding conformance to the CHWR = 56F requirement without consideration for undesirable consequences. Unreasonable investment in buildings or wasteful energy practices should be avoided. These exceptions should be discussed, clarified, and approved during schematic design on an individual project basis. During this low coil load scenario, chilled water return to the CUP may be gradually relaxed, at the same time the AHU supply air discharge temperature is gradually raised through a controlled re-set schedule. Using creative instrument control sequences, it may be possible to increase CHWR to greater than 56F - this is acceptable and desirable

(good design practice should strive to minimize all flow through the decoupled bypass/bridal connection – both to artificially cause CHWR = 56F to be a set maximum or set minimum).

6. 2-way Control Valve:
   a. Temperature control of the chilled water return back to the CUP must be maintained through a direct acting temperature control loop. The control valve and actuator assembly must be of industrial quality with a combined approximate 100:1 turn-down ratio.
   b. The control valve will need to be able to close against the possible 100 psi (230' W.C.) differential pressure from the central plant pumps and have 3-5 psid across the valve at full flow.
7. Process Cooling:
   a. Process cooling loads may require a special application during periods of low building load (cold outside air temperature conditions). Process cooling loads are assumed to be generally constant irrespective of outside weather conditions, 24 hours per day and 7 days per week (HVAC loads will be able to take advantage of outside air economizers). Process loads should have coils sized for warmer chilled water for those periods of time when the CUP will have elevated supply temperatures as it operates in free cooling mode (it is likely that the heat exchanger could return water warmer than 56F).
   b. Serving process loads during winter weather will often require the use of a smaller "minimum flow" chilled water pump for low load conditions as the main pump VFD control usually does not want to reduce flow to below 30% of schedule chilled water flow (end of main bypass with 3-way control valves should not be used).
8. High Static Head Problem:
   a. CUP pumping operation at future build-out is based on a fixed maximum working pressure. During peak operation, dynamic pump head in combination with potential static head due to a high column of water, could exceed the CUP design basis if precaution is not considered. To that end, the highest point of the building chilled water piping system (including all connected equipment and piping) should not be higher than an elevation of 5,475 FT A.S.L. because of the static pressure induced on the campus system by the building piping system. In this case, use a flat plate heat exchanger(s) and building circulation pump(s) to isolate the building and campus chilled water systems (typically process loads are isolated in a tertiary pumping loop using a heat exchanger, in some cases the entire building will be served by a chilled water heat exchanger).
9. Flat Plate Heat Exchanger:
   a. Use of a flat plate heat exchanger is required when the highest point of the building chilled water piping system exceeds the elevation of 5,475 FT A.S.L. because of high static head. Alternatively buildings may have both a direct de-coupled chilled water connection to the CUP and an indirect connection through the use of a heat exchanger. In many cases, in buildings with significant process cooling requirements, these cooling loads will all be served by a chilled water heat exchanger and a downstream tertiary pumping loop. In either case, the chilled water piping system downstream of the heat exchanger must be considered as an isolated system. This system must have provision to manage its own makeup water and chemical treatment. The piping system downstream of the heat exchanger must have provision for expansion capacity. The tertiary chilled water system should be designed to utilize warmer chilled water to account for both a 3 F approach or less and elevated CUP chilled water supply temperatures during winter operation (please see CUP free cooling mode chilled water supply reset).
   b. If the entire building is served by a flat plate heat exchanger (ideally this should be avoided if AHU's can be kept below the approximately tenth story roof elevation) – when significant building chilled water equipment is above the specified elevation or if the process cooling heat exchanger is directly connected to CUP chilled water system, then the direct connection of the heat exchanger to the primary chilled water distribution network should be sized for a differential pressure of no more than 6.5 psid at the maximum flow (source side).
10. Central Utility Plant Water Treatment Management:
   a. No makeup water or chemicals shall be introduced into the chilled water system at the

building when directly connected to the CUP system. All chemical treatment will occur at the CUP. Piping system expansion capacity for each building project will be provided for at the CUP. The building mechanical systems designer must provide the campus Facilities Operations engineering staff with the calculated amount of expansion required for the building project from the point of connection with the campus system. All equipment and connections shall be specified for 150 psig ratings (flanges, gaskets, Victaulic connections, etc.). This is the rating of the campus distribution system chilled water piping.

11. Chilled Water Meter Specification: Please see section 23 09 00.
12. Reference Drawings:
    a. The following diagrams are referenced in the above text and are for general use and design discussions. Valves are shown as a generic valve symbol and are not meant to depict a particular type of valve. It is important to emphasize again, that each particular installation is unique and may require a different approach to the installation.
        1) REF DWG 1: Steam Connections Inside Buildings
        2) REF DWG 2: Chilled Water Connections Inside Buildings

W. Energy Conservation:
1. The university is dedicated to the principle of conserving energy and will scrutinize proposed construction for means of reducing not only initial cost, but also long range operating and maintenance costs. Buildings will be designed making the most efficient use of building materials and energy sources available. Compliance with the standards in ASHRAE Standard 90 is a minimum requirement.
2. Give consideration to building utilization by planning for conservation between summer and winter and for periods of minimum occupancy. Design systems that require 24 hours/day operation separate from those that may require only 8 hours/day operation. Systems serving spaces with special year-round cooling loads e.g., computer rooms, data centers, equipment rooms, shall be designed separate from the building HVAC system.
3. Conservation of energy should be a significant factor in specifying or selecting equipment, system, controls, and sequence of operation. The alternatives shall be evaluated through life-cycle costing and presented to the campus energy engineer through the University Project Manager for approval.

X. Equipment Rooms:
1. Separate mechanical equipment rooms from electrical equipment rooms. Limit access to these rooms to authorized maintenance personnel only. House equipment requiring access by building or laboratory personnel separately.
2. Arrange access to equipment rooms so entry will not disturb the occupants or normal functions of the building. Outside access doors are preferable. Coordinate door sizes with the largest equipment size. Provide adequate heights for walking and moving equipment into and out of room.
3. Comply with ASHRAE standards and State of Colorado regulations for design and construction of mechanical refrigeration systems and related monitoring, ventilation, and storage of refrigerants.
4. Arrange and locate equipment rooms so that heat and sound will not be transmitted to other parts of the building. Insulation and ventilation are required where applicable per standard requirements. Where applicable size service elevators for equipment removal from basements and penthouses.
5. Locate equipment having parts which must be removed for maintenance (filter, coils, fan shafts, tube bundles, etc.) so that removal may be accomplished with adequate access and without interference with other functions of the building.
6. Surround the room with a 6 inch curb, a 2 inch cant, and waterproof the floor. Provide floor drains and slope floor to drains.
7. Provide high water detection alarms in all mechanical and equipment rooms at lowest point of floor. Provide a 3/4 inch conduit between high water alarm and the specified alarm panel for remote alarm.
8. Where possible lifting eyes should be permanently placed to aid in lifting and removal of mechanical equipment weighing over 100 pounds. Lifting eyes shall not be blocked by any device.

Y. Pipe and Duct Spaces in Chases:
1. Provide excess horizontal and vertical area in duct chases and pipe runs for future use where

possible 25%, office buildings should have 10% excess.

2. Provide full size doors for access at each floor of chase with steel floor grating for service and maintenance. Provide additional reduced size access doors where full size doors will not work to maintain and service devices and/or components within the duct.

Z. Pipe and Duct Penetrations:
1. Specify and detail the manner in which pipes pass through roofs, walls, floors, and ceilings. Fire ratings must be maintained for all penetrations. The Contractor responsible for cutting or drilling holes and flashing, sealing, or otherwise furnishing them must be clearly designated in the project documents.
2. Design pipe, and duct penetrations so that minimum opening remains after installation. Seal openings to prevent passage of rodents, birds, bugs, fire and smoke. Materials used shall be sufficient to maintain fire rating of the wall, floor, ceiling and/or roofs.
3. Provide for continuous insulation for pipes and ducts passing through openings.
4. Provide tubing or pipe (not sheet metal) sleeves for all utility services passing through structural walls and slabs. All sleeves passing through slab floors shall project a minimum of 1 inch above the slab and be sealed water tight to the slab.
5. Provide toe boards and handrails when floor grating is more than 4 feet above the walking surface below.

AA. Provide concrete curbs in mechanical rooms to contain water spills.

BB. Access/Accessibility:
1. Any device, equipment and/or component having a moving part or that requires maintenance and/or service shall be easily accessible. If it is located above solid ceiling, in a chase or other concealed areas, an access door shall be provided so that parts can be exchanged and work be done as required. Minimum panel size to be 24 inches by 24 inches
2. Design and install utility distribution systems (i.e., conduit, piping, ductwork, etc.) in a layered configuration in the areas of renovation or new construction. Take into account the access to devices, equipment, and/or components.
3. Locate access to equipment and valves outside critical areas, clean rooms, and red zones. Obtain a list of specific areas from the University Project Manager.
4. Locate systems to provide access to devices and components that require access or maintenance. Design system hierarchy above ceilings as follows:
    a. Plumbing waste, vent piping and roof drain mains and leaders.
    b. Cable trays
    c. Supply, return, and exhaust ductwork
    d. Fire sprinkler mains and leaders.
    e. Electrical conduit and duct banks.
    f. Domestic hot and cold water, medical gas piping
    g. Fire sprinkler branch piping and sprinkler run-outs.
5. Submit a system layering plan including electrical components to the University Project Manager for review and approval as part of the Schematic design phase of each project.

CC. Acoustical Criteria:
1. Design systems to provide noise levels from equipment and ductwork not to exceed, ASHRAE NC-35 in class room, 40-45 in laboratories in all 8 octave bands.
2. Coordinate acoustical requirements for application specific areas.
3. Exceptions:
    a. Spaces within 15 foot radius from supply and return ducts from shafts: NC-40.
    b. Lobbies, Toilets, Commercial Areas: NC-45 – 50
    c. Kitchens: NC-45 to 50.
    d. Mechanical Rooms: NC-50 to 60.

DD. Temporary Facilities:

1. Do not use permanent building equipment without written permission from the University Project Manager. If equipment is used for temporary heating or cooling, maintain equipment per manufacturer's instructions and protect with filters, strainers, controls, reliefs, etc. Do not start the guarantee period until the equipment is turned over to the university for use.

EE. Painting:
1. All piping, conduit and equipment in unfinished areas shall be painted as required for preservation and identification.
2. All exposed work in finished areas shall be painted for appearance as directed by the Architect.
3. Painters will cover or mask off equipment tags, nameplates, etc., before painting and then remove masking in such a way that it does not destroy the information on the tag or nameplate.

FF. Process and Control Air:
1. Air supply for control of HVAC devices having electric or electronic components shall be dried through a refrigeration air dryer or desiccant dryer.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01300 and as required by various Section of Divisions 21, 22, and 23 with the following provisions:
1. Submittals will be reviewed by the Engineer to determine that the materials, equipment, and installation methods are in accordance with the project design concepts. The Contractor shall be responsible for space requirements, configurations, performance, bases, supports, structural members and openings in structure, and other apparatus that may be affected by the material, equipment, or installation.
2. Include current, published catalog and specification sheets pertaining to proposed material and equipment.
3. Identify each item with identification symbols identical to those used on the drawings and/or in the specifications.

B. Operation and Maintenance Manual: Furnish operation and maintenance manuals for equipment and systems installed under Divisions 21, 22, and 23 of the standards in accordance with Section 01730 and the following.
1. Submit one copy of the manual to the Engineer for preliminary review prior to production of the final manuals.
2. Following review of the preliminary manual by the Engineer prepare and submit final copies of the manual complying with the Engineer's comments noted on the preliminary manual.
3. Include the following information:
    a. Alphabetical list of all system components with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
    b. Manufacturer's data that are applicable to the installed equipment such as the following:
        1) Shop drawings (reviewed and accepted
        2) Product and performance data (reviewed and accepted)
        3) Installation instructions
        4) Lubrication instructions
        5) Wiring and temperature control diagrams (reviewed and accepted Shop Drawings)
        6) Parts lists
        7) Copies of warranties
        8) A compilation of the manufacture's recommended maintenance schedule and routines for each piece of equipment
    c. A simplified description of the operation of each system including, the function of each piece of equipment within the system. Support descriptions with a schematic flow diagram when applicable.
    d. Emergency procedures for equipment operation during a fire or following the failure of major equipment. Describe procedures for normal starting, operating, shutdown, and long-

term shutdown.

e. Maintenance instruction including valves, valve tag, and other identified equipment lists, proper lubricants and lubricating instruction for each piece of equipment, and necessary cleaning, replacing, and adjusting schedules.
f. Assembly, installation, alignment and adjustment instructions.
g. System balancing report.
h. Temperature controls, cut sheets and record drawings.
i. Commissioning checklists and certification.

C. Record Documents: Furnish record documents for equipment and systems under Divisions 21, 22,and 23 of the Standards in accordance with Section 01720 and the following:
1. Mark drawing prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers, and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located. Note changes of ductwork or piping on the drawings if it has been relocated more than 1 foot from where shown on the drawings.
2. List all equipment parameters on the drawings in schedules whenever possible. Include room number where equipment is located.
3. At the completion of the project, mark all valve tag numbers on the drawings and turn these drawings over to the University Project Manager.
4. Provide standard long-form specifications.

D. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.

1.4 QUALITY ASSURANCE

A. Installer Qualification:
1. Workmanship shall conform to the highest industry standard for each specific type of work.
2. Perform work in accordance with standard commercial practices.

B. Comply with Part 3 of this manual, state and federal codes, rules and regulations. As a minimum requirement, codes, rules and regulations take precedence over the drawings and specifications. Where the requirements of the drawings and specifications exceed those of applicable codes, rules and regulations, the drawings and specifications shall govern.

C. Chemical and physical properties, design, and performance characteristics of all material and equipment, and methods of construction shall be in accordance with the following applicable codes, regulations and standards. Current editions in effect 30 days prior to receipt of bids will apply.
1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Movement and Control Association, Inc. (AMCA)
3. American Gas Association (AGA)
4. American National Standards Institute (ANSI)
5. (ASHRAE) American Society of Heating, Refrigerating and Air Conditioning Engineers
6. American Society of Mechanical Engineers (ASME)
7. American Standard Code for Pressure Piping (ASCPP)
8. American Society for Testing and Materials (ASTM)
9. American Water Works Association (AWWA)
10. Compressed Gas Association (CGA)
11. Environmental Protection Agency (EPA)

1.5 DELIVERY, STORAGE AND HANDLING

A. All mechanical equipment and materials shall be delivered, stored and handled in accordance with

manufacturers instructions and the requirements of Section 01 10 00.

1.6 WARRANTY

A. All mechanical equipment, materials and workmanship warranties shall be provided in accordance with the requirements of Section 01740 and the following:
   1. Warranty all equipment, materials, workmanship, and proper operation of equipment and apparatus for a period of one year from date of final acceptance unless indicated otherwise in the individual sections. Extended warranty periods are identified in individual sections.
   2. Compile and assemble the warranties specified in the individual sections into the operating and maintenance manuals.
   3. Provide complete warranty information for each item to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As specified in individual sections.

2.2 MATERIALS, GENERAL

A. Products:
   1. Provide material and equipment new and free from defects.
   2. Install all material and equipment in accordance with the manufacturer's current published recommendations.
   3. Certain materials and equipment are specified by manufacturer and model or catalog number. Such specified items are the basis of design and establish a degree of quality, performance, and physical configuration.
   4. Equipment and materials manufactured by any one of the manufacturers listed on the drawings or in the specifications will be acceptable.
   5. Where no manufacturer is listed, provide a standard product meeting the requirements of the drawings and specifications, and manufactured by a firm regularly engaged in the manufacture of such products. All equipment, when possible, shall be:
      a. Manufactured and purchased in Colorado
      b. Manufactured and purchased in the USA.
   6. Requests prior to bid for approval of equipment or material not specified shall be done in accordance with the requirements of Section 01 25 00.

PART 3 - EXECUTION

A. Additional charges will not be authorized due to the contractor's failure to become familiar with the existing conditions.

3.2 INSTALLATION, GENERAL

A. Permits and Inspections:
   1. Secure all required permits, the university will pay for permit and inspection costs.
   2. Pay all applicable royalties, inspection fees, taxes, and licenses.

B. Responsibility of Contractor:
   1. The contractor is responsible for the complete installation and satisfactory operation of all work in accordance with requirements of the drawings and specifications.
   2. The component parts of the installation shall function together as workable systems. Each system shall be left with all parts adjusted and in proper working order.

C. Coordination:
   1. Coordinate project in accordance with Section 01040.

D. Scaffolding, Rigging, and Hoisting:
   1. Provide all scaffolding, rigging, and hoisting necessary to safely accomplish the work following OSHA requirements.
      a. Remove from premises when no longer needed.
   2. Provide necessary services to deliver, erect, place, and install all equipment and apparatus furnished.

E. Damaged Surfaces:
   1. At completion of the work, all mechanical material and equipment furnished shall be inspected for damage.
      a. Repair damaged factory finishes to match adjacent, undamaged areas.
      b. Replace deformed metal cabinets, jackets, and enclosures with new items. Finish shall match similar undamaged items.

3.3 TESTING, CLEANING AND CERTIFICATION

A. Cleanup:
   1. At completion of the work, check and thoroughly clean all equipment.
      a. Clean coils and plenums.
      b. Clean under, in, and around equipment.
         1) Clean exposed surfaces of piping, ducts, and hangers.
         2) Clean equipment cabinets and enclosures.
         3) Provide and install new filters for equipment.

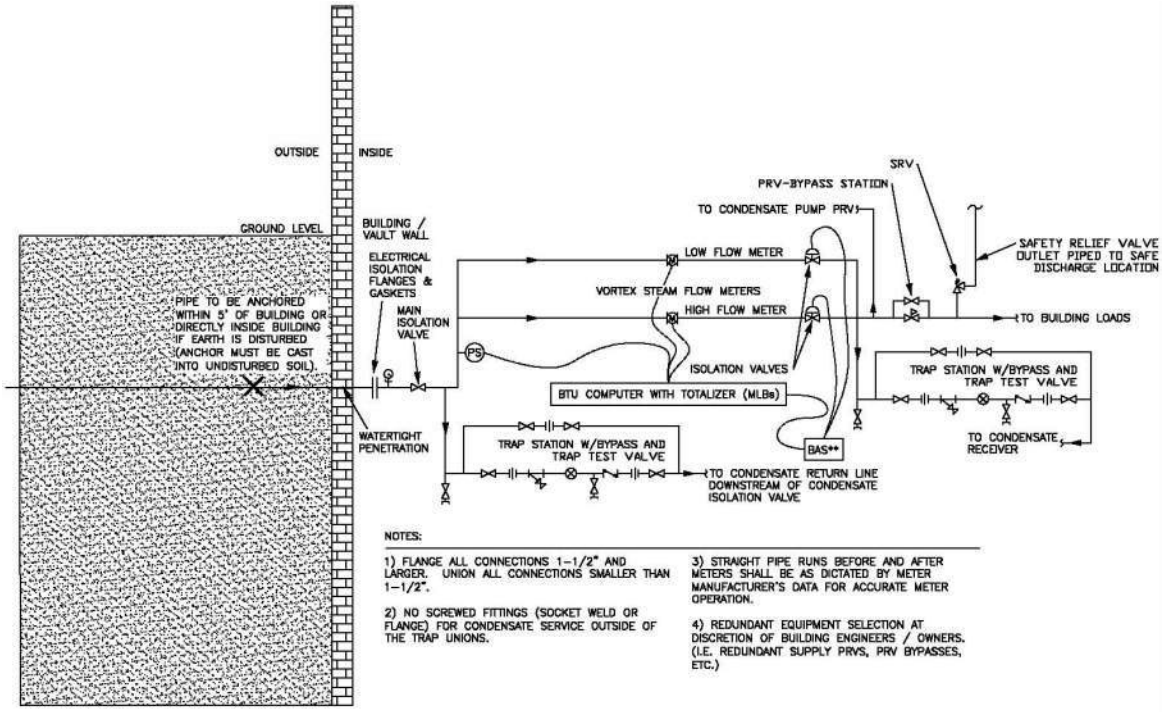
B. Project Closeout:
   1. Verify that all work has been completed prior to requesting final walkthrough, including Contractor's preliminary review of mechanical systems start-up and acceptance checklists.

3.4 COMMISSIONING (DEMONSTRATION)

A. Training and Demonstration: Schedule instructional meetings for the university's Facilities Operations maintenance personnel on the proper operation and maintenance of mechanical systems. Provide the project manager a minimum of 5 days notice prior to any training, demonstration, or testing.

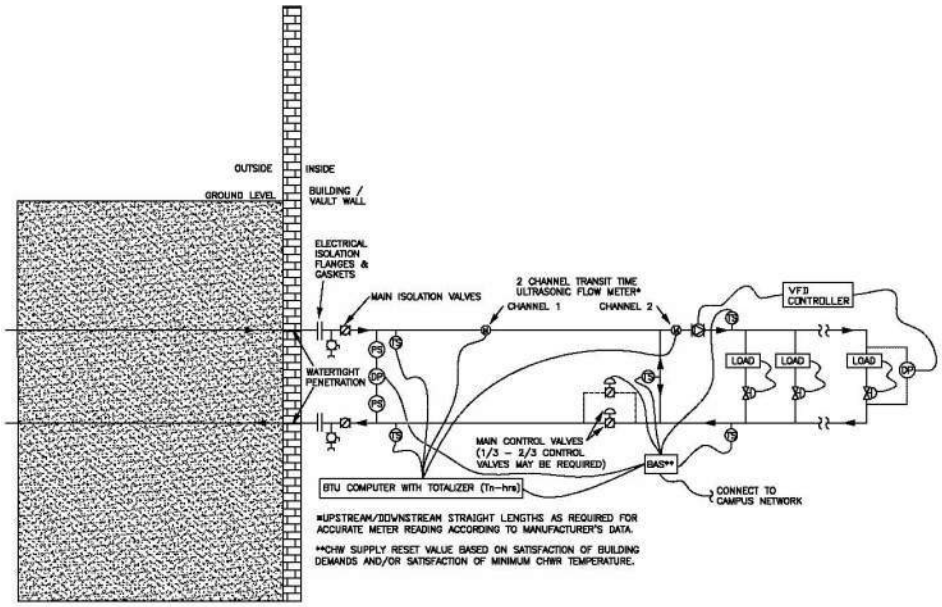
PART 4 - ILLUSTRATIONS

A. REF DWG 1: Steam Connections Inside Building

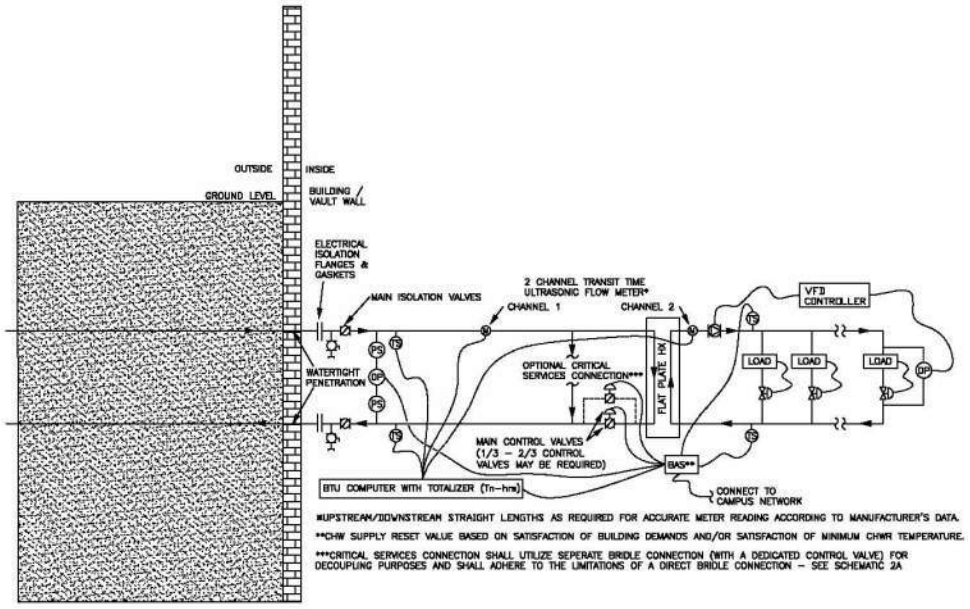


REF: SCHEMATIC 1 STEAM CONNECTION INSIDE BUILDING

B. REF DWG 2: Chilled Water Connections Inside Building



REF: SCHEMATIC 2A CHILLED WATER CONNECTIONS
INSIDE BUILDINGS WITH BRIDLE



REF: SCHEMATIC 2B CHILLED WATER CONNECTIONS
INSIDE BUILDINGS WITH HEAT EXCHANGER

END OF SECTION 23 00 00

SECTION 23 0005 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General and Supplementary Conditions and Division 1 - Specification Sections and Contract Documents apply to work in this section. Consult them for further instructions and be governed by the requirements there under.

1.2 SUMMARY OF WORK

A. Description of Systems
   1. The work of Division 23 includes but is not limited to Heating, Ventilating and Air Conditioning Systems.

B. Work Included
   1. Furnish all labor and materials and perform all operations necessary for the installation of complete and operating mechanical systems subject to the conditions of the contract. The work also includes the completion of such mechanical and electrical details not mentioned or shown which are necessary for the successful operation of all systems; this includes the furnishing of all materials for filling systems to make them operable, including water, refrigerant, oil and grease. Prove satisfactory operation of all equipment and controls to the Consulting Mechanical Engineer on request.

C. Work Not Included (Specified Elsewhere)
   1. Certain labor and materials may be furnished and/or installed under other divisions of these specifications. Coordinate with other trades and arrange the work to make the parts fit together. The following items are to be accomplished under other divisions of these specifications.
   2. Fixed concrete bases for mechanical equipment: Division 3. Anchor bolts, setting diagrams, base sizes and other required information furnished under Division 15.
   3. Concrete for inertia bases for mechanical equipment: Division 3. Steel forms provided under Division 15.
   4. Concrete surrounding buried ductwork: Division 3. Tie downs for buried ductwork under Division 15.
   5. Masonry wall opening lintels: Division 4.
   6. Wall openings and Chases: Under applicable sections according to information furnished under Division 23.
   7. Access Panels: Furnished and located by Division 23 installer as specified in Division 8 for installation by appropriate trades.
   8. Painting (except mechanical identification systems): Division 9.
   9. Roof Curbs
      a. Curbs for all equipment located on the roof shall be furnished under Division 6 except for any prefab curbs specified herein. Roof flashings to be specified under Division 7. All counter flashing shall be furnished and installed by this Contractor of the same material as specified in Division 7.

D. Equipment Furnished by Owner
   1. General: Also see Division 1.

2. Rough-in service pipes to locations as required by architectural and mechanical drawings and equipment shop drawings. Provide service valves on all pipes except waste and vent pipes, plug or cap these. Final connections to equipment will be made by MC. (This Contractor will provide all necessary equipment or items required for final connections to equipment).

E. Examination of Premises
1. Visit the premises before submitting bid as no extras will be allowed for lack of knowledge of existing conditions.

F. Inspection
1. Inspect work proceeding or interfacing with work of Division 23 Sections and report any known or observed defects that affect the work to the General Contractor. Do not proceed with work until defects are corrected.

G. Definitions
1. "Provide" means Contractor is responsible for the furnishing and installation of.
2. "Exposed" means visible from the floor of a room or area.
3. "Concealed" means in such spaces as pipe chases, pipe trenches, above plaster ceilings, in walls and buried where pipe is inaccessible when building is completed.
4. "Conditioned" space, means any space which is within the exterior insulation boundary or layer and is heated by the mechanical system or by an adjacent space. Mechanical rooms and ceiling plenums are classified as "conditioned" spaces.
5. "Mechanical Room" means any space or area which contains equipment providing heating, cooling, ventilation, plumbing distribution, or mechanical/plumbing system utility generation and distribution capabilities. These spaces are defined as "Mechanical Rooms" even if they are called by another name (i.e. boiler room, chiller room, machine room, etc.).

1.3 COORDINATION

A. General
1. Coordinate and order the progress of mechanical work to conform to the Owner's schedule and the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Utility Interruptions
1. Coordinate mechanical utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

C. Cutting and Patching
1. See Division 1.

D. Drawings and Specifications
1. Mechanical drawings are diagrammatic and because of the small scale, it is not possible to indicate every required offset, fitting, etc. Drawings are not to be scaled for dimensions. Take all dimensions from Architectural drawings, certified equipment drawings and from the structure itself before fabricating any work. Verify all space requirements, coordinating with other trades, and install the systems in the space provided without extra charges to the Owner.
2. Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the General Contractor and obtain written instructions for any changes necessary.
3. All documents are complimentary. What is required by one document is binding as if by all.

E. Ceiling Cavity

1. Confer, cooperate, and coordinate work with other trades. Coordinate ceiling cavity space carefully with all trades. In event of conflict, install mechanical and electrical systems within cavity space in following order of priority.
   a. Plumbing waste and vent piping
   b. Roof drain piping
   c. Hydronic piping
   d. Ductwork
   e. Electrical conduit and lighting
   f. Domestic hot and cold water piping
   g. Fire sprinkler piping.

1.4 REFERENCE STANDARDS

A. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
B. The date of the standards that is in effect at the bid date, or date of Owner/Contractor Agreement when there are no bids, except when a specific date is specified or when the standard is part of an applicable code which includes an edition date.
C. When required by individual Specification section, obtain copy of standard. Maintain copy at job site during work until Substantial Completion.
D. Schedule of Referenced Organizations. See Division 1.

1.5 SUBMITTALS

A. Submit samples, shop drawings and product data as required by various sections of Division 23 in accordance with Division 1. Make submittals to Architect. Do not make submittals directly to Engineer.

1.6 SUMITTALS AND SHOP DRAWINGS

A. Conform to requirements of Division 1 and following paragraphs.
B. Submittals shall include catalog cut-sheets, manufacturer's data sheets, written descriptions, and specification sheets detailing the associated product, item, and assembly.
C. Shop drawings shall include details, installation drawings, assembly drawings, fabrication drawings, diagrams, and other information which show adaptation or installation of Contractor-furnished products or materials for overall project.
D. Prior to ordering equipment or beginning installation work, assemble, prepare, and furnish submittals and shop drawings required for project. Furnish submittals and shop drawings as required by individual sections of specifications.
E. Contractor shall thoroughly check subcontractors' or vendors' submittals and shop drawings and, after approving them, submit them for review. Submittals and shop drawings that do not bear Contractor's review stamp will be returned Not Reviewed.
F. The purpose of submittals and shop drawings is to ensure that Contractor understands design requirements and demonstrates understanding by indicating and detailing intended materials, methods, and installation practices. Submittals and shop drawings are not a method of requesting substitutions or deviation from Specifications. If discrepancies between submittals, shop drawings, and Contract Documents are discovered either prior to or after submittals and shop drawings are reviewed, requirements of Contract Documents shall take precedence. Submittals and shop drawings which are submitted, but which are not required by Contract Documents, will be returned Not Reviewed.
G. Review of submittals and shop drawings and action recommended as result of review is courtesy

extended to Contractor by Owner's representative. This review is intended to minimize delivery to job site and installation of materials and equipment that do not meet intent of Construction Documents. Submission of material for review does not alter Contractor's obligation to follow intent of Construction Documents, nor Contractor's responsibility to comply therewith.

H. Submittals and shop drawings shall identify specific equipment with numbers or letters identical to those listed or scheduled on the Drawings or Specifications.

I. Each set of submittals and shop drawings submitted or re-submitted shall bear a unique Contractor's submittal number. Submit minimum of copies as required by Division 1. After review, submittals and shop drawings will be returned together with Submittal Review Sheet which indicates comments on submittals and shop drawings and with specific actions such as: No Exception Taken; Make Corrections Noted, Re-submittal Not Required; Make Corrections Noted, Re-submittal required; Rejected; Not Reviewed. Continue to re-submit submittals and shop drawings until No Exception Taken or Make Corrections Noted, Re-submittal Not Required action is indicated.

1.7 RECORD DOCUMENTS

A. Keep in custody during entire period of construction, a current set of documents indicating changes that have been made to the Contract Documents. Changes to be noted on the documents shall include but shall not be limited to piping or ductwork location more than 2'-0" from where shown on Drawings, changes in pipe and duct size, location of valves and cleanouts. Mark valve tag numbers on Drawings. Incorporate Addenda, accepted Alternates, Change Orders, and other Document revisions which occurred after the award of the General Contract or the start of construction activities into the Record Documents. Notations and changes shall be done in a neat and legible manner in accordance with Architect's instructions. Changes shall be noted in red, deletions in green, and notes in blue.

B. Upon completion of work, submit the complete set of Record Documents to the Architect. The Contract Documents set the standard for content and methods of presentation for the changes shown.

C. The Contract shall not be considered completed until these Record Documents have been reviewed and accepted by the Architect.

1.8 DELIVERY, STORAGE, HANDLING

A. Provide delivery and safe storage of materials and equipment. Make provisions for introduction into building of equipment too large to pass through finished openings. Provide for hoisting of equipment.

1.9 PROTECTION OF EQUIPMENT

A. Protect materials and equipment from physical damage, construction dirt, and the elements from time of shipment to time installation is accepted by Owner.

B. Protect mechanical work against theft, injury, or damage from all causes.

1.10 GUARANTEE

A. Guarantee materials, workmanship, and operation of equipment installed for period of one year from date of acceptance of entire Work. Repair or replace any part of work which shows defect during that time.

B. Be responsible for damage to property of Owner or to work of other contractors during construction and guarantee period.

C. Furnish equipment warranties to Owner.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 MECHANICAL EQUIPMENT WIRING AND CONNECTIONS

A. Voltage characteristics shall be as in Electrical Division of Specifications and on Electrical Drawings.

3.2 DEMOLITION

A. During demolition, carefully remove existing equipment, piping, ductwork, and related items as required for Work. Tag items, protect from damage, and store as directed by Owner. Deliver list of items stored to Owner. At completion of work or when directed by Architect, remove from job site stored items not reused or wanted by Owner.

B. Hazardous material may exist at job site. If hazardous material is discovered, stop work in that area, notify Architect. Owner will remove hazardous material. Do not resume work in that area until notified to do so by Owner.

C. Dispose of or recycle refrigerant and refrigeration equipment in accordance with State and Federal regulations. Capture and recycle to be performed by District. Contractor shall coordinate with the District and notify District a minimum 1 week prior to demolition.

3.3 CUTTING AND PATCHING

A. Locate all holes and chases required for work during progress of construction; provide properly sized metal sleeves or wood boxes for sleeving. Before beginning sleeving or installation work, study Contract Drawings and check piping, ductwork, equipment locations for interference with other trades. If conflicts are discovered, submit recommended solution for approval prior to installation. Do all cutting, repairing, structural reinforcing for installation of work per Architect's directions. Do not cut for any reason without Architect's approval.

B. Sleeves and chases are prohibited in any structural member except where approved by Architect.

C. Cut and patch all openings in existing walls, floors, and roof as required for ductwork and piping. Patching consists of completing work to match and blend in with adjoining existing work. Patches which are not properly blended shall be redone. Do patching work with craftsmen qualified and skilled in type of patching work required.

3.4 TEMPORARY FACILITIES

A. Light, Heat, Power, Etc.: Provide temporary power supply or other facilities required for Work. Arrange with proper parties to bring facilities from services to required location on premises.

B. Use of Existing Equipment for Temporary Heating or Cooling: Do not use new or existing building equipment without written permission from Owner. If building equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. Guarantee period shall not start until equipment is accepted by Owner.

3.5 INSPECTIONS

A. Do not cover up or enclose work until inspected, tested, and approved. Any work enclosed or covered up before such approval shall be uncovered, tested, and approved.

3.6 ACCESS DOORS

A. Furnish hinged steel access doors with concealed latch, whether shown or not, in walls and plaster or gypsum board ceilings for access to concealed valves, shock arresters, air vents, motors, fans, balancing valves, or other operating devices requiring adjustment or servicing.

B. Access door shall be size of equipment to be removed or 24" by 24" if used for service only.

C. Furnish doors to trades performing work in which they are to be installed. Group valves, devices, and other equipment, to permit use of minimum number of access doors.
D. Doors shall be type compatible with finish in which they are to be installed.

3.7 SUPERVISION
A. Supervise work to proceed in proper sequence without delay to other contractors. Keep supervisor on premises at all times to ensure that intent of Drawings and Specifications is being followed.

3.8 INSTALLATION
A. Workmanship shall be first quality. Appearance of work shall be of equal importance to its mechanical operation. Lack of quality workmanship shall be reason for rejection of system in part or in whole.
B. Install so that all valves and equipment can be easily accessed and serviced by adequate clearance, installation of access doors, unions in piping, or other methods.
C. Complete installation shall function smoothly and noiselessly.
D. Install equipment and materials per manufacturers' recommendations and local codes or regulations.
E. Place or replace all equipment nameplates where they can be seen and read without difficulty.

3.9 LUBRICATIONS OF EQUIPMENT
A. Lubricate equipment before operating and before turning over to Owner.

3.10 TESTING
A. All tests specified herein and/or called for by authorities having jurisdiction shall be witnessed by Architect or Owner.
B. Upon completion of the work, deliver certificates of inspection and final approval to Owner.

3.11 SYSTEM START-UP AND TESTING
A. Start up and test all equipment per manufacturer's instructions. Operate system to establish proper operation and performance. Make necessary adjustments and corrections.
B. Owner shall be present as start-up. Provide minimum 3-days notification to owner when start is to occur.
C. Certify to Owner in writing that system has been operated and tested and is operating to design performance requirements.

3.12 COMPLETION
A. Clean insulation covering, ducts, pipes, equipment, and accessories to receive prime coat of paint. Clean equipment received with prime coat to receive final coat.
B. Replace air filters if units were operated during construction. Clean ducts, blowers, and coils if units were operated without filters during construction.
C. Instruct Owner in operation and maintenance of mechanical systems. Minimum participants shall include mechanical contractor and controls contractor representatives.
D. After tests and adjustments have been made and systems pronounced satisfactory for permanent operation, refinish damaged finish and leave everything in proper working order and appearance.
E. On completion of work, remove tools, scaffolding, debris, etc., from grounds and leave premises clean.

3.13 PROJECT CLOSE-OUT
A. Upon written notice from the Contractor certifying that the work is complete and ready for inspection, Engineer will prepare punchlist of items determined to be incomplete or otherwise not in compliance with intent of Contract Documents.

B. When required, subsequent visit to review completion of punchlist work will be made after receipt of written statement from Contractor indicating punchlist work is complete. Include copies of intermediate observation reports and final punchlists with individual items initialed by Contractor to attest that individual work items are completed.
C. Contractor shall pay Engineer's costs at the billing rates in effect at the time the services are performed for subsequent punch list visits required due to lack of completion of prior punch list.

3.14 OPERATION AND MAINTENANCE MANUALS

A. Prior to completion of project, submit three (3) sets of maintenance manuals covering operation and maintenance of mechanical equipment with moving or movable parts, including plumbing systems. Instructions shall be in pamphlet or typewritten form in three ring binders. Instructions for each unit shall be indicated by separate tab.
B. Include test and balance report.
C. Include valve tag list.
D. Include name, address, and telephone number of party to be contacted for 24-hour service for each item of equipment.
E. Include starting, stopping, lubrication, preventative maintenance schedule, and adjustment information for each piece of equipment.
F. Include guarantees and warranties of all equipment.

END OF SECTION

SECTION 23 05 13 - MOTORS

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Provide mechanical/electrical coordination schedule on the drawings and coordination section in the specifications to clarify power and control wiring.

B. Altitude Deration: Motors shall operate within nameplate horsepower at 5000 feet elevation. Do not operate on service factor.

C. Energy Efficiency: Select and specify energy efficient motors with nominal efficiency equal to or greater than that stated in NEMA MG 1, 1.41.3, for motor type and rating. Motors specifically manufactured for a particular piece of equipment with a lower efficiency shall be brought to the attention of the Project Manager.

D. On variable frequency drives (VFD) applications Provide motors rated for inverter-duty with attached steel nameplate indicating “Inverter-Duty Motor”

E. Use VFDs to drive motors 1- horsepower or larger on variable flow systems

F. Starters: Starters shall be specified in Division 26 . Consult with Electrical Engineer and ensure starters are scheduled and provided.

G. Motor drive sheaves shall be a minimum of one size smaller than the driven pulleys. No variable pitched sheaves allowed.

H. Motor Control Centers:
1. Where a large group of starters can be centrally located, it will be beneficial to have these assembled in a motor control center (MCC) and specified in Division 26.
2. Where starters are specified in a MCC in Division 26, close coordination is required with the Electrical Engineer to make sure starters match specific motor requirements for part winding start, auto transformer type starting, wye/star-delta closed transition type or where two speed motors have been specified.
3. Provide adequate space in design for installation of field panels to contain relays and point cards for remote start-stop and status indication.

I. Manual Control:
1. Specify maintained-contact push buttons with pilot lights for single-speed or multi-speed operation.

J. Automatic Control:
1. Specify magnetic starters for motors 1/2 horsepower and larger and for smaller motors with interlock or automatic operation.
2. Specify auxiliary contacts if needed. Provide space for future.
3. Specify “Hand-Off-Automatic” switches in starter cover with externally operated manual reset.
4. Specify trip-free thermal overload relays for each phase. Size for 125 percent of rated load.

1.2 WARRANTY

A. Provide option for an extended warranty package on variable frequency drive package including motor matched to drive.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Motors
      a. Baldor
      b. Magneteck
      c. Toshiba
   2. Variable Frequency Drives: Purchase VFD and motor from one distributor. Drive manufacturers shall submit a list of acceptable motors for use with the proposed drive.
      a. Toshiba
      b. Siemens
      c. ABB
      d. Yaskawa
   3. Shaft Grounding Kits:
      a. Preferred: Helwig Carbon BPK
      b. Other options: SGS

2.2 MATERIALS, GENERAL

A. Motor Frames and Mounts: Equip motor frames with two axis adjustments, namely slotted frame ends for adjusting in shaft direction and two adjusting screws for belt tensioning.
   1. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
   2. Motors shall be capable of starting the driven equipment while operating at 90 percent rated terminal voltage.
   3. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
   4. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design “B”, except “C” where required for high starting torque.
   5. Provide inverter-duty motors specifically designed for variable speed operation with premium efficiency at part load conditions a constructed with Class F insulation for equipment specified to operate with variable frequency drives.
   6. Phases and Current characteristics: Unless indicated otherwise, provide squirrel-cage induction poly-phase motors for 3/4 hp and larger, and provide capacitor-start single-phase motors for 1/2 hp and smaller, except 1/6 hp and smaller may be split-phase type.
   7. Provide motors for operation at 5000 foot elevation or higher.
   8. Motors smaller than 1 hp to be single-phase. Motors larger than 1 hp to be 3-phase.
   9. Motors 1 HP and larger shall be inverter-duty, with nominal efficiency equal to or greater than that stated in NEMA Standard MG1, 1.41.3.
   10. Match motor electrically to the drive (a package unit).
   11. Motors for pulse-width modulating (PWM) drives will have both motor bearings isolated.
   12. Motors, 5hp and larger, must be driven by PWM.
   13. Bearings:
      a. Ball or roller bearings with inner and outer seals on sizes up to 1.5”. Ball or roller bearings with inner and outer shields on sizes greater than 1.5” shaft dia.
      b. Regreasable except permanently sealed where motor is normally inaccessible for regular maintenance.
      c. Sleeve type for light-duty, fractional horsepower equipment.

B. Drives:
   1. Rated capacity of V-Belt drives shall not be less than 150 percent of motor nameplate horsepower.
   2. Fixed pitch sheaves, including single groove fan sheaves shall be of the bushed type. No fixed pitch sheave shall be smaller than 3” dia.
   3. Variable pitch sheaves are not allowed.

4. Provide OSHA approved belt guard with tachometer holes.
5. For equipment serving hazardous or critical systems such as fume hoods, and bio-hazards, provide fans with a minimum of two-groove sheaves and fan belts.

C. Variable Frequency Drives:
1. Drive shall convert constant frequency AC line voltage to a variable frequency, variable voltage AC output suitable for control of variable frequency, NEMA design B induction motor, with full-load amp rating between 10 percent and 110 percent of the drive full load current capability, without requiring modifications to the motor or drive.
2. VFD for motors shall have the following features.
   a. One motor per drive. No sharing of drive by two motors, except for air handler "fan –wall" applications. Provide separate overload for each fan in "fan wall".
   b. Pulse width modulation.
   c. Enclosure type - NEMA 1. Provide bypass power and controls in separate enclosure.
   d. AC line fused disconnect or circuit breaker. Provide door interlock disconnect.
   e. AC line reactors in drive cabinet for protection against line notching and surges without requirement for an input isolation transformer. Minimum impedance of line reactors shall be 2.5 percent. Maximum total harmonic distortion shall not exceed 3 percent per IEEE. Input isolation transformers are not permitted.
   f. Metal oxide varistors on incoming line for transient protection.
   g. Manual speed potentiometer, HAND-OFF-AUTO switch and 4-20 milli-amp signal follower, fully isolated and suitable for grounded or ungrounded input signal.
   h. RS485 communication port and protocol capable of full communication with the Siemens FLN. The drive control should act as an application and allow monitoring and manipulation of points from the Siemens front-end software. VFD parameters to be password protected. VFDs shall stop when there is no longer communication to the BAS system, unless otherwise required.
   i. Current Rating: A minimum continuous current rating of the VFD shall be a continuous ampere rating suitable for operation of a premium efficiency motor, VFD continuous amps shall not be less than the amps specified in NEC Table 430-150 for the specified horsepower motor. Additionally, provide VFD to operate at 125 percent of design motor load. Overcurrent rating shall be 110 percent for one minute minimum.
   j. Instantaneous overcurrent shutdown with indicator lamp when current exceeds 200% of nameplate values.
   k. Inverse characteristic time-overcurrent overload protection for the motor sized in accordance with NEC requirements.
   l. Drive shall be capable of withstanding random application of an output short circuit without damage to drive components or fuses.
   m. Input phase loss and under voltage protection.
   n. Torque/current limit control which will slow the motor without tripping when the motor is subjected to an overload, or slow the acceleration ramp when accelerating a high inertia load.
   o. Automatic restart circuitry to restart motor after a momentary or sustained power failure, phase loss, or non-damaging fault trip. No more than 5 restart attempts should be allowed before lockout. Auto restart feature shall be switch defeatable. For fan applications, the VFD shall be capable of restarting into a spinning load.
   p. Cabinet ground lug in VFD enclosure.
   q. Troubleshooting diagnostic features of diagnostic fault display to show reason for trip. Display shall differentiate between: input under voltage, input phase loss or blown fuse, instantaneous overcurrent, sustained motor overload, heat sink over-temperature, over voltage, etc. Diagnostic test unit may be of the plug-in type, with one test unit provided for several VFDs. If plug-in type unit is provided, provide minimum of one for each building.
   r. LED indicators, for all normal operation functions, including on-off status of all power SCRs or transistors, and bypass LED indication when the drive is in bypass.
   s. Test mode switch to allow operation and setup of control electronics with power circuitry disabled.

t. Availability of critical speed avoidance option which could be added to VFD in the field at a future date.
u. UL listed.
v. Rated and sized for 5000 foot elevation operating condition.
w. Automatic soft start feature to start motor at lowest speed and ramp slowly up to required speed on start-up and for any abrupt increases in required speed.
x. Factory test of each unit for a minimum of 2 hours of burning at elevated temperatures of 122-176 degree F prior to shipping.
y. Bypass device (automatic and manual) to allow for total isolation of drive unit for service, while providing for temporary operation of motor. This shall include:
    1) A main disconnect switch in the bypass enclosure with a door interlock handle which provides positive shutdown of all power to both bypass circuitry and VFD. The by-pass shall be in a separate enclosure from the VFD.
    2) VFD output contactor and a constant speed contactor.
    3) Three pole motor overload relay with heaters connected to shut down the motor in both VFD and bypass modes.
    4) Timing relay adjustable 5-30 seconds to prevent rapid switching from bypass to VFD modes.
    5) A control relay and terminal blocks which allows two-wire, start-stop control of motor from a single remote contact in both VFD and bypass (auto) modes.
    6) Control relay and terminal blocks to allow connection of remote interlock shutdown contacts such as freeze stats, smoke detectors, etc. When this interlock loop is opened, operation of the motor shall be disabled in both VFD and bypass modes.
    7) Four position oil-tight selector switch for VFD-OFF-BYPASS (AUTO)-BYPASS (MANUAL). Indicator lights on face of bypass panel with long life neon or transformer type incandescent bulbs to indicate "POWER ON", "MOTOR ON VFD", "MOTOR ON BYPASS CONTROL", "MOTOR OVERLOAD", "INTERLOCK SHUTDOWN".
    8) 120 volt control power transformer with fused secondary and primary.
    9) Bypass mode operation shall be independent of VFD control power.
    10) Output contactor shall be wired to allow a controlled VFD deceleration ramp to stop.
    11) Panel shall be arranged to allow power-off maintenance of VFD while motor is operating on bypass. Bypass circuitry in same compartment as VFD is not permitted.
z. Locate test switches, LED readouts or digital readouts on outside of panel.
aa. Correction for long-lead length as pertains to over voltage problems at the motor will be the responsibility of the installer. Electrical correction will be implemented as required to achieve and maintain safe and smooth motor operation. Leads shall not be longer than 50 ft.
bb. Provide current transformers with adjustable, internal, current sensitive, normally open and normally closed contacts (one each), for Bypass, Drive, and motor contactor conductors (for status).
cc. At least two pre-set speed-control modes in drive circuitry.
dd. Disconnect at motor shall have auxiliary contact so that when disconnect is opened, the control circuitry to the drive will be interrupted.
ee. VFDs shall not be located inside the cabinets of controlled equipment.
ff. VFD shall control interlock with associated damper end switches. Coordinate with sequence of operations.
gg. VFDs to be programmed for speed not less than 18Hz or 30%.

3. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.
4. Provide shaft grounding kits for all motors used with VFDs.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Motor Frames and Mounts: Mounts for adjustments of belt tension shall be of the two-pull variety.

B. Variable Frequency Drives: Install floor mounted variable frequency drives on 4-inch high concrete housekeeping pad.

C. Correction for long-lead length at the motor will be the responsibility of the installer. Electrical correction will be implemented as required to achieve and maintain safe and smooth motor operation.

D. Disconnect at the motor shall have auxiliary contact so that when disconnect is opened the control circuitry to the drive will be interrupted. Provided by Division 26.

E. VFD shall have sheet metal splash pans above the drives when hydronic piping is located above the VFD.

3.2 TESTING, CLEANING, AND CERTIFICATION

A. Factory test variable frequency drives under simulated operation. Provide certification of factory test.

B. Testing: Test and start VFD's and bypass under actual conditions by factory trained personnel. Operate VFD's through its full range to determine resonant speeds,.

3.3 COMMISSIONING (DEMONSTRATION)

A. Start-up of variable frequency drive equipment shall be performed by factory authorized representative. Provide checklist certifying equipment startup and operation.

3.4 TRAINING

A. Provide the university's representative 2 hours of training by factory authorized representative for each variable frequency drive installed. Training includes startup, shutdown, emergency operation, maintenance and servicing.

PART 4 - CHANGE LOG

11/4/2021 1. Added Yaskawa to 2.1, A, 2., Updated shaft grounding kits.

END OF SECTION 23 05 13

SECTION 23 05 19 - METERS AND GAUGES

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Air Filters: Provide pressure switches and magehelic gauges across main building air filters.. Monitor each section separately and monitoring and gauges shall have separate tubing.

B. Pressure Reducing Valves: Provide single pressure gauge on upstream and downstram of pressure reducing valves to independently indicate high and low pressure.

C. Heating Water Systems: Provide solar-powered digital thermometers in wells on hot water systems, domestic and heating, to indicate supply and return temperatures.

D. Air Systems: Provide visual on HVAC air distribution equipment to indicate temperatures at supply, return and mixed air points.

E. Pumps: Provide separate pressure gauge in suction and discharge and temperature taps in pipes at each pump section and discharge. Do not use pump housing ports for gauges.

F. Chilled and Condenser Water Systems: Provide dial thermometers in wells to indicate supply and return temperatures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Glass Thermometers:
      a. Marshalltown Instruments, Inc.
      b. U.S. Gage
      c. Mueller
   2. Direct Mount Dial Thermometers:
      a. Marsh Instrument Co.; Unit of General Signal
      b. Trerice (H.O.) Co.
      c. Weiss Instruments, Inc.
   3. Remote Reading Dial Thermometers:
      a. Ametek/U.S. Gauge
      b. Marsh Instrument Co.; Unit of General Signal
      c. Weiss Instruments, Inc.
   4. Dual Type Insertion Thermometers and Wells:
      a. Marsh Instrument Co.; Unit of General Signal
      b. Taylor Instrument Co.
      c. Weiss Instruments, Inc.
   5. Temperature Gauge Connector Plugs:
      a. Fairfax Company
      b. Peterson Equipment Co.
      c. Universal Lancaster
   6. Pressure Gauges and Plugs:
      a. Ametek/U.S. Gauge
      b. Marsh Instrument Co.; Unit of General Signal
      c. Weiss Instruments, Inc.
   7. Pressure Gauge Connector Plugs:

a. Fairfax Company
b. Peterson Equipment Co.
c. Universal Lancaster

8. Venturi Flow Measuring Elements:
   a. FDI (preferred)
   b. HCI
   c. Gerand
9. Calibrated Balancing Valves:
   a. FDI (preferred).
   b. HCI
   c. Gerand
10. Automatic Balancing Valves
    a. FDI (preferred)
    b. Griswold

2.2 MATERIALS, GENERAL

A. Thermometers:
1. Case: Die cast aluminum, finished in baked epoxy enamel, glass front, spring secured, 9 inches long.
2. Adjustable Joint: Die cast aluminum, finished to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.
3. Tube and Capillary: Spirit filled, magnifying lens, 1% scale range accuracy, shock mounted.
4. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
5. Stem: Copper plated steel, or brass, for separable socket, length to suit installation.
6. Range: Conform to the following:
   a. Hot Water: 30 degree - 240 degree F with 2 degree F scale divisions.
   b. Chilled Water: 0 degree - 100 degree F with 2 degree F scale divisions.

B. Dial Type Insertion Thermometers
1. Type: Bi-metal, stainless steel case and stem, 1 inch diameter dial, dust and leak proof, 1/8 inch diameter stem with nominal length of 5 inches.
2. Accuracy: 0.5% of dial range.
3. Range: Conform to the following:
   a. Hot Water: 0 degree - 240 degree F
   b. Chilled Water: 0 degree - 100 degree.

C. Thermometer Wells:
1. Thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

D. Temperature Gauge Connector Plugs:
1. Temperature gauge connector plugs pressure rated for 500 psi and 200 degree F (93 degree C). Construct of brass and finish in nickel-plate, equip with 1/2 inch NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8 inch OD probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

E. Pressure Gauges:
1. Type: General use, 1% accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.
2. Case: Drawn steel or brass, glass lens, 4-1/2 inch diameter.
3. Connector: Brass with 1/4 inch male NPT. Provide protective siphon when used for steam service.
4. Scale: White coated aluminum, with permanently etched markings.
5. Range: Conform to the following:

a. Vacuum: 30 inch Hg - 15 psi
b. Water: 0 - 200 psi
c. Steam: 0 - 150 psi. High pressure
1) 0 - 25 psi. Low pressure

6. Provide all steam pressure gauges with pigtail and shut-off valve suitable for temperature and pressure for specified service.

F. Pressure Gauge Cocks:
1. Brass with 1/4 inch female NPT on each end and "T" handle brass plug
2. 2. Siphon: 1/4 inch straight coil constructed of brass tubing with 1/4 inch male NPT on each end. On steam pipe only.
3. 3. Snubber: 1/4 inch brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

G. Pressure Gauge Connector Plugs:
1. Provide pressure gauge connector plugs pressure rated for 500 psi and 200 degree F. Construct of brass and finish in nickel-plate equipped with 1/2 inch NPS fitting, and self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8 inch OD probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

H. 2-1/2 Inch and Larger Venturi Flow Measuring Elements:
1. Primary flow measuring elements consisting of solid brass or bronze venturi tubes. Tubes larger than 2 inches may be cast iron or steel. Steel tubes may be fabricated or cast with cadmium or zinc-plating. Line throats of cast iron tubes with bronze and plate cast iron portion with cadmium. Each station complete with safety shutoff valves, and quick coupling connections for use with a master portable meter set or individual permanently mounted meter. Tubes calibrated and tested by independent testing laboratory and performance data furnished with shop drawings.
2. Manufacturer shall certify venturi for actual piping configuration. Any necessary piping changes required for certification shall be provided without cost.
3. Provide venturi with throat diameter such that specified rate of flow will register scale reading of between 20% and 80% of full scale value.
4. Unrecovered head loss at maximum flow shall not exceed 10% for venturi used with permanently located meters and shall not exceed 12 inches w.g. when used with portable meters.
5. Provide each primary element with integral tab or metal tag on stainless steel wire extending outside pipe covering on which is stamped or clearly printed in plainly visible position the following information:
a. Manufacturer's name and address.
b. Serial number of meter to which element is to be connected.
c. Name, number or location of equipment served.
d. Specified rate of flow.
e. Multiplier (including unity, where applicable) to be applied to meter reading, including correction for operating temperatures and glycol solutions.
6. Provide taps with shutoff valves and quick connecting hose fittings for portable meters.

I. Inches and Smaller Calibrated Balance Valves:
1. Calibrated balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT O-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.

J. Portable Flow Meters:

1. Provide differential pressure gage and two 12-foot hoses in carrying case with equalizing manifold, check seals, and appurtenances. Plus or minus 2 percent accuracy between 20 to 80 percent of range. Provide master chart for conversion of meter readings to gallons per minute. Provide adapters as necessary.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Temperature Gauges:
1. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.
2. Locations: Provide in the following locations and elsewhere as indicated:
   a. At inlet and outlet of each chiller.
   b. At inlet and outlet of each condenser.
   c. At inlet and outlet of each hydronic coil in air handling units and built-up central systems.
   d. At inlet and outlet of each hydronic heat exchanger or converter.
   e. At inlet and outlet of each hydronic heat recovery unit.
   f. At inlet and outlet of each thermal storage tank.
   g. At inlet and outlet of each pump.
   h. At each air handler to monitor Supply Air, Return Air, and Mixed Air temperatures.
   i. Primary and secondary chilled water supply and return and bridal connection
3. Thermometer Wells: In vertical upright position. Fill well with oil or graphite, secure cap.
4. Temperature Gauge Connector Plugs: Located on pipe at most readable position. Secure cap.

B. Pressure Gauges:
1. General: Provide pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
2. Locations: Provide in the following locations:
   a. At suction and discharge of each pump.
   b. At inlet and discharge of each pressure reducing valve.
   c. At water service outlet.
   d. At inlet and outlet of water cooled condensers and refrigerant cooled chillers.
   e. At steam source heating equipment including but not limited to converters and hot water generators.
   f. At BAS heating or cooling differential pressure sensor
3. Pressure Gauge Cocks: Provide in piping tee with snubber. Install siphons for steam pressure gauges.
4. Pressure Gauge Connector Plugs: Located on pipe at most readable position. Secure cap.

C. Flow Measuring Devices:
1. General: Provide flow measuring devices on piping systems located in accessible locations at most readable position.
2. Arrange piping in accordance with manufacturer’s published literature. In horizontal pipes, place connections slightly above horizontal centerline of pipe.
3. Install so connections for attachment to portable flow meter hoses is readily accessible
4. Locations: Provide in the following locations and elsewhere as indicated:
   a. At discharge of each pump.
   b. At inlet of each hydronic coil in built-up central systems.
5. Calibrated Balance Valves: Provide on piping with readout valves in vertical upright position. Maintain minimum length of straight unrestricted piping equivalent to 5 pipe diameters upstream and downstream of valve and/or fittings.

3.2 TESTING, CLEANING AND CERTIFICATION

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows to meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

C. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR PIPING

PART 1 – GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. General Information:
1. Show all valves on the drawings. Do not rely on a general note in the specifications or on the plans.
2. For applications up to 2", specify full port ball valves. Butterfly valves are acceptable if pressure and leak risks are low.
3. Valves adjacent to equipment should have unions/flanges provided to allow for removal with minimal labor effort.

B. Isolation Valves:
1. Provide valves for isolating sections of piping systems. It should be possible to isolate; the entire building, separate floors, separate wings, toilet rooms, machinery rooms and other natural subdivisions of the buildings.
2. Provide valves for isolating equipment and fixtures. Place valves on both sides of backflow and check valves to permit inspection.
3. Do not use isolation valves for balancing and do not use balancing valves for isolation.
4. Isolation valves can be ball type (up to 2 inch), gate, or butterfly as deemed appropriate by designer for the type of service, pressure, and fluid.
5. Ball valves are acceptable as isolation valves for most hot water heating systems, domestic water systems, distilled or ionized water systems, blow-down valves, drain valves and other low hazard, low pressure systems.
6. Gate valves are required as isolation valves for steam supply and condensate return systems, chilled water supply, and condenser water systems and other high hazard, high pressure systems. Gate Valves installed on steam systems must have stainless steel gates and seats
7. Butterfly valves are acceptable alternates as isolation valves for chilled water systems, and other low hazard, low pressure, systems where the entire system can be shut down if necessary to accommodate leaky isolation valves.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hydronic Ball Valves:, Apollo, Crane, Jamesbury or Jenkins.

B. Hydronic Gate Valves (less than 2 inches): Stockham, Crane, Grinnell Corp, or Jenkins.

C. Hydronic Gate Valves (2 inches or larger): Crane, Jenkins, Lunkenheimer, or Walworth.

D. Hydronic Butterfly Valves: Dezurik, Crane, Jenkins, Stockham, Keystone or Centerline.

E. Steam and Condensate Gate and Globe Valves: Stockham, Crane, Jenkins, or Walworth.

F. Steam and Condensate Butterfly Valves: Jamesbury, Vanessa, or Keystone.

G. Heating Water P/T Relief Valves: Bell & Gossett, Watts, Farris, Kunkle, Watts Regulator Co., or Spirax Sarco.

H. Circuit Setters: FDI, Armstrong, Bell & Gossett, Tour Anderson.

2.2 MATERIALS, GENERAL

A. Ball Valves:
1. Blowout proof stems, 3-piece, full port type, brass or bronze body, chrome plated or stainless steel ball, Teflon seals and seat, vinyl-covered handle with memory stop. Pressure rating 150 psi SWP and 600 psi WOG.
2. Ball valves shall be 2 inch or less. Larger pipe sizes shall require gate or butterfly valves.

B. Gate Valves: Solid wedge, rising stem type, except where clearance is a problem.

C. Globe Valves: Renewable disc, rising stem. Install where throttling may be necessary.

D. Butterfly Valves: Cast iron body, lug style, 150 psi pressure rating, aluminum bronze disc, 416 stainless steel stem, EPDM seat. Provide with cap screws instead of stud bolts to permit valve to remain in place with one flange removed.

E. Balancing or Throttling Valves:
1. Use eccentric plug, globe or angle valves for balancing. Do not use gate valves.
2. Butterfly valves equipped with memory stops may be used as balancing valves.

F. Safety Relief Valves: Brass or bronze body, designed, rated, and stamped in accordance with ASME. Steel and cast iron body valves may be used for steam service.

G. Gas Valves: Lubricated plug or AGA-approved ball valves.

H. Clean Steam: 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General Duty Valve Applications: The drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff duty: Use valve type as indicated on drawings and in this section.
2. Throttling duty: Use globe (steam only) and plug (heating and chilled water).

B. Install shutoff duty valves at each branch connection to supply mains, at supply mains, at supply connection to each piece of equipment and elsewhere as indicated.

C. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.

D. Install plug valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.

E. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage. Provide 1/2-inch ball valves with chain end cap at all tops of risers to be used for venting.

F. Install check valves on each pump discharge and elsewhere as required to control flow direction.

G. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.

H. Install safety relief valves on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.

I. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.

J. Install valves with stems upright or 45 degree maximum, never inverted. When and if steam valves have to be mounted inverted they shall have a valve bonnet drain.

K. Mount all valves so operation is possible without interference from pipes, pipe hangers, walls, etc.

L. Valves (4 inches and larger) located more than 7 feet above floor in mechanical equipment rooms shall be chain operated.

M. Install valves easily accessible. Provide access panels when it becomes necessary to install valves above gypsum ceilings.

END OF SECTION 23 05 23

SECTION 23 05 53 - IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL (NOT USED)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Identification Devices:
      a. Seton Name Plate Company
      b. Marking Services, Inc.
      c. National Marker Co.
   2. Paint:
      a. Benjamin Moore
      b. Devoe
      c. Glidden

2.2 MATERIALS, GENERAL

A. Plastic Pipe Markers
   1. Pipe labels that adhere to pipe or insulation surface with directional arrows.

B. Tags:
   1. Engraved anodized aluminum or engraved plastic, 2-inch diameter. Pre-punched and provided with brass chain.

C. Labels and Nameplates:
   1. Laminated three-layer plastic with black engraved letters on light contrasting background color, drilled for mounting with two sheet metal or brass screws. Pressure-sensitive embossed labels are not acceptable.

D. Paint Stencils:
   1. Use metal stencils only. No cardboard stencils are allowed.
      a. Size of Legend and Letters for Stencils:

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
3/4” to 1-1/4”	8”	½”
1-1/2” to 2”	8”	¾”
2-1/2” to 6”	12”	1-1/4”
Ductwork & Equipment	N/A	2-1/2”

E. Paint:
   1. Exterior grade oil-based alkaloid gloss stenciling spray paint. Color complying with NEMA Z535.1.

F. Underground Plastic Line Markers:
   1. Multi-ply tape consisting of solid aluminum foil core between 2 layers of plastic tape, not less than 6-inches wide x 4 mils thick.

G. Valve Schedule Frames:
   1. Provide frames of finished hardwood or extruded aluminum, with non-glare glass.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide pipe identification, valve tags, stencils, or engraved name plates to clearly identify all mechanical equipment, including motors, piping and controls of the various mechanical systems and direction of flow in piping.

B. Plastic Pipe Markers
1. On bare pipe when surface temperature exceeds 180 degree F provide a 1- inch thick insulation band under marker for protection from the hot pipe.

C. Piping, Ducts, and Equipment Identification:
1. Piping:
a. Identify all piping accessible for maintenance in crawl spaces, tunnels, above ceilings, and access spaces as well as exposed to view utilizing stenciled markings according to the following procedures:
1) Use an arrow marker for each pipe-content legend. The arrow shall always point away from the pipe legend and in the direction of flow. Color and height of arrow to be same as content legend lettering.
2) If flow can be in both directions, use a double-headed arrow indication.
3) Apply pipe legend and arrow indication at every point of pipe entry or exit where line goes through wall or ceiling cut.
4) Apply pipe legend and arrow indication within 3 inch of each valve to show proper identification of pipe contents and direction of flow.
5) Apply legend to the pipe so that lettering is in the most legible position. For overhead piping, apply legend on the lower half of the pipe where view is unobstructed, so that legend can be read at a glance from floor level.
6) Pipes under 3/4 inch O.D.: Fasten brass tags securely at specified legend locations.
7) Legend on steam piping, condensate return, compressed air, gas, and vacuum systems: Include working pressure or vacuum.
2. Valves:
a. System service valves located inside the building: Tag and identify as to type of service.
b. Valves or cocks controlling branch mains or risers to various portions of the building: Tag and identified as to service and location.
3. Controls:
a. Magnetic starters and relays: Install nameplates or stencil to identify connecting or controlled equipment.
b. Manual operating switches, fused disconnect switches and thermal over-load switches which have not been specified as furnished with indexed face plates: Install nameplates or be stencil as to controlled equipment.
c. Automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays, and starters: Clearly identified with unit served and function.
d. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches with nomenclature corresponding to operating instructions in the "Operation and Maintenance Manual". Coordinate with the university Facilities Operations personnel through the university Project Manager.
4. Fans:
a. Label exhaust fans, air handling units and connecting ductwork supplying one or more areas from an equipment room or isolated crawl or furred space. Install nameplate or stencil as to plan code number, service and areas or zones served.
5. Pumps:
a. Identify as to service and zones served.
b. Install nameplate or stencil system served on base mounted pumps.
c. Install brass tags secured by tie wires on small in-line pumps.
6. Storage Tanks, Water Treatment Equipment and Heaters:
a. Stencil service on tanks and heaters

b. Label connecting pipes and indicate the service temperature entering and leaving the tank or heater.

7. Air Conditioning Equipment:
   a. Equipment such as chillers, pumps, condensers, or rooftop equipment: Identified by stencils, or system nameplates. Labels of remote equipment shall also indicate the space(s) being served and the location of their electrical breaker (Panel ID, Room No. And Circuit).
   b. Identify locations of air handling devices which have filters and are above accessible ceilings by a blue circular dot or tack at least 3/4 inch in diameter, or embossed tape, adhered to the nearest T-bar.
8. Access Doors:
   a. Provide engraved nameplates or painted stencils to identify concealed valves, controls, dampers or other similar concealed mechanical equipment.
   b. Identify the locations of fire dampers above accessible ceilings with a red circular dot at least 3/4 inch in diameter, or embossed tape, adhered to the nearest T-bar. Access door shall be painted red.
   c. Obtain the university Project Manager's approval before installation on all access doors in finished areas.
9. Lift-Out Ceilings:
   a. Provide engraved nameplates on ceiling tee stem (screwed or riveted, adhesive not allowed) to identify concealed valves, filters, fire/smoke dampers or similar concealed mechanical equipment that is directly above nameplate in ceiling space.
   b. Obtain the university Project Manager's approval before installation.
10. Terminal Units:
    a. Identify all units with unique numbers corresponding to the drawings, and indicate the space being served.
    b. Use engraved plastic laminate labels affixed to each box by screws or rivets.

3.2 SCHEDULES

A. Piping Identification

Classification	Color of Field	The Campus Letters	Legend
Materials Inherently Hazardous:			
Flammable or Explosive:			
Natural Gas	Yellow	Black	NG
Lab Waste	Yellow	Black	AW
Extreme Temperatures or Pressures:	Yellow	Black	
Domestic Hot Water	Yellow	Black	Dom HW
Domestic Hot Water, Circulating	Yellow	Black	Dom HWC
Heating Water Supply	Yellow	Black	HWS
Heating Water Return	Yellow	Black	HWR
Low Pressure Steam	Yellow	Black	LPS
Low Pressure Steam Condensate	Yellow	Black	LPSC
High Pressure Steam	Yellow	Black	HPS
High Pressure Steam Condensate	Yellow	Black	HPSC
Boiler Feed Water	Yellow	Black	BFW
Refrigerant	Yellow	Black	REF
High Pressure Compressed Air (over 90 psig)	Yellow	Black	CA
Materials of Inherently Low Hazard:			
Liquid or Liquid Admixture:	Green	White	
Distilled Water	Green	White	DW

Classification	Color of Field	The Campus Letters	Legend
Domestic Cold Water	Green	White	Dom CW
Sanitary Sewer	Green	White	SAN
Waste Vent	Green	White	V
Chilled Water Supply	Green	White	CWS
Chilled Water Return	Green	White	CWR
Condenser Water Supply	Green	White	CS
Condenser Water Return	Green	White	CR
Gas or Gaseous Admixture:	Blue	White	
Medium Pressure Compressed Air (30 to 90 psig)	Blue	White	CA
Low Pressure Compressed Air (less than 30 psig)	Blue	White	CA
Vacuum	White	Black	VAC
Fire Quenching Materials:			
Fire Lines	Red	White	FL

B. Mechanical Equipment Naming Strategy:

1. Equipment identification numbers may be up to 32 characters. Equipment naming strategy is:
   System – Bld – Number
   ###-#####-##-###
2. The first three placeholders are reserved for the system designation (alpha characters)
3. The fourth character is a hyphen.
4. The fifth through ninth placeholders are reserved for the building designation (alpha and/or numeric)
5. The tenth character is a hyphen
6. The eleventh through sixteenth placeholders are a “smart number.” It is composed of a two-digit, alpha or numeric, floor location designator followed by a hyphen and a three digit numeric sequential indicator.
7. The seventeenth character is a hyphen
8. In some instances the point name will be followed by a hyphen and a sub-point name
9. All device and point names will be assigned by the Facilities Operations, Building Operations Department.
10. All references to equipment and devices in drawings, labels, equipment tags, BAS system, etc., must use this naming convention.
11. Equipment designation, for prints may exclude the building designator.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SYSTEM PERFORMANCE REQUIREMENTS

A. Require general, mechanical and electrical contractors to coordinate and cooperate with the TAB contractors as necessary to allow them to perform work.

B. Items such as start-up, initial testing, cleaning, calibration of controls, electrical testing, etc., are to be completed prior to the commencement of TAB work.

C. Submit name of balancing and testing agency with resume of the agency, including qualifications of personnel to be used and authority and responsibilities of personnel.

D. Product data shall be submitted, in accordance with Section 23 00 00, for each of the following :
   1. Procedure Submittal: Prior to commencing work, submit, for approval, a written procedure of how balance will be performed and a description and manufacturer's name of equipment and instruments to be used. The submittal shall include, but not necessarily be limited to the following:
      a. List of preliminary checks to be performed at the job site such as confirmation that manual volume dampers are present, filters are installed, frequency drive units operational, location of control sensors, etc.
      b. Identify how the air outlets will be measured and the type of instruments to be used.
      c. Locations of pilot traverses and the type of instruments to be used.
      d. Modes of operation that the system will be placed in during balancing and testing, i.e., full cooling and heating, maximum and minimum outside air flows, maximum and minimum sash positions for fume hoods, toilet fans on or off, etc.
      e. Position of doors and windows during balance, i.e., some labs should be balanced with doors shut.
      f. Operating static pressures for terminal devices and pressure sensors for controlled devices.
      g. Method of adjusting outside and return air quantities at air handling units.
      h. Initial test procedures for preliminary balance.
      i. Final test procedures.
      j. List of deficiencies in mechanical system that could hinder the balance work such as missing or leaky dampers, incomplete systems, inadequate fans, etc.
      k. Sample of data sheets and test forms to be used in final report.
      l. Identification and manufacturer's name of equipment to be used on project and proof of last calibration on each piece.
   2. Progress Report(s) – Report, in writing, any deficiencies or problems with air or water systems that have affected balance work. Include items that affect system performance such as broken thermostats, damaged ductwork, excessive noise, etc.

1.2 QUALITY ASSURANCE

A. Test, adjust, and balance systems in accordance with ASHRAE Applications Handbook. For NEBB certification, comply with "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." For AABC certification, comply with "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."

B. TAB contractors shall present to the University Project Manager and general contractor, proof of current equipment certification approved by National Institute of Standards and Technology.

C. Testing Agency Qualifications: Agency shall be NEBB or AABC certified in testing and balancing disciplines required for this project. Work shall be performed under direct supervision of professional engineer, NEBB, or AABC certified supervisor.

D. Guarantee of Work: TAB contractor shall guarantee the balancing for a period of 90 days from date of acceptance of final report. During this period, the TAB contractor shall make personnel available at no cost to the university to verify measurements and/or correct deficiencies in the balance. During this period, emergency adjustments shall not void this warranty.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Pre-Balancing Conference: Before beginning testing, adjusting, and balancing procedures, schedule and conduct a conference with University Project Manager, Facilities Operations Representative(s) and representatives of installers of mechanical and control systems. Conference objective is final coordination and verification of system operation and readiness for testing, adjusting, and balancing, and assigning testing responsibilities of each installer.

B. Systems shall be complete and fully operational prior to beginning procedures. Insure all items such as thermometer wells, pressure test-cocks, access doors, etc., are installed to facilitate tests and adjustments.

C. Put all heating, ventilating, and air conditioning systems and equipment into full operation and continue operation during testing and balancing.

D. Before air balance work is started, check system for duct leakage, install a complete set of clean filters, check for correct fan rotation and equipment vibration, and check automatic dampers for proper operation. Set volume control dampers and outlets in wide open position. Ensure fire dampers are open and that return air paths are not obstructed.

E. Prior to performing hydronic balance work; check system for plugged strainers, proper pump rotation, and proper control valve installation and operation. Check air vents at high points of systems to ensure all are installed and operating freely (automatic type) or bleed air completely (manual type); and verify proper flow meter and check valve installation and proper system pressure.

F. All throttling devices and control valves shall be set open.

G. Performing Testing, Adjusting, and Balancing:
1. Cut insulation, ductwork, and piping for installation of test probes to minimum extent necessary to allow adequate performance of procedures.
2. Patch insulation, ductwork, and housings, using materials identical to those removed.
3. Reseal ducts and piping, and test for and repair leaks.
4. Reseal insulation to re-establish integrity of the vapor barrier.
5. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other permanent identification materials.
6. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

H. Sequencing and Scheduling:
1. Systems shall be fully operational before beginning procedures.

2. Conduct tests in the presence of the University Project Manager after providing 7-day notice before any test is to be conducted. Provide water and electricity required for tests. Determine that all dampers, registers, and valves are in a set or full open position.

I. Balancing:
1. Water Balance:
a. Balance water piping and snow melt systems to produce water quantities within 5 percent of design flow rates for cooling water systems and within 10 percent of design flow rates for heating water systems.
b. Hydronic systems shall be proportionally balanced, ensuring the path to one terminal is fully open. Total system flow shall be adjusted at pump by restricting discharge balancing valve.
c. Indicate and record final position of balancing valves.
d. Primary-Secondary Flow Systems: Balance primary system crossover flow first, then balance secondary system.
e. Pumps:
1) Verify pump impeller size and pump rotation.
2) Measure flow.
3) Measure inlet and outlet pressures.
4) Measure motor full load amperage at design flow and shut-off condition.
f. Heat Exchangers:
1) Measure water flow through all circuits.
2) Measure inlet and outlet water temperatures.
3) Calculate capacity in btu-h.
4) Measure inlet steam pressure. Check setting and operation of automatic temperature-control valves and pressure reducing valves.
5) Record safety valve settings.
6) Verify operation of steam traps.
g. Chillers:
1) Balance water flow through each evaporator and condenser with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed flow for maximum tube velocity recommended by chiller manufacturer. Perform tests and record data with each chiller operating at design conditions for:
a) Evaporator and condenser water entering and exiting temperatures, pressure drop, and water flow.
b) Evaporator and condenser refrigerant temperature and pressures.
c) Calculate capacity in tons.
2) For air cooled chillers, verify condenser fan rotation and record fan data, including number of fans and entering and exiting air temperatures.
h. Cooling Towers:
1) Shut off makeup water for duration of test and ensure makeup and blow-down systems are fully operational after tests. Perform tests and record data for:
a) Condenser water flow to each cell of cooling tower.
b) Entering and exiting water temperatures.
c) Wet, and dry, bulb temperatures of entering and exiting air.
d) Condenser water flow rate recirculating through cooling tower.
e) Cooling tower pump discharge pressure.
f) Fan cfm and static pressure for each cell.
i. Heat Transfer:
1) Measure entering and exiting water temperatures and pressures.
2) Measure gas flow rate.
3) Measure water flow.
4) Calculate capacity in btu-h.
j. Water Coils:
1) Measure entering and exiting water temperatures and pressures.
2) Measure water flow rate.

3) Measure entering and exiting dry, and wet, bulb air temperatures.
4) Measure airflow. Measure air pressure drop. Calculate capacity in btu-h.

k. Finned Tube Radiation:
1) Measure entering and exiting water temperatures.
2) Measure water flow rate.
3) Calculate capacity in btu-h.

l. Evaporative cooling:
1) Adjust water flow across media per manufacturer.
2) Adjust bleed rates.
3) Adjust fill rates.

2. Air Balance:
a. Balance duct system to produce air quantities within 10 percent of indicated value.
b. Dampers: Adjust automatic damper linkages to provide air flow quantities shown. Check all automatic dampers in normal operation to verify proper operation. Verify return, relief air, and fresh air intake dampers operate as designed to produce desired room comfort.
c. Place all fans (supply, return, and exhaust) in operation. Load or restrict filters to increase pressure drop to 50% of span between initial pressure drop and final recommended pressure drop for setting final air flows for fans. Check the following:
1) Motor amperage and voltage to guard against overload.
2) Fan rotation.
3) Operability of static pressure limit switch.
4) Automatic dampers for proper position.
5) Air and water resets operating to deliver required temperatures.
6) Air leaks in casing and in safing around coils and filter frames.
d. Traverse Main and Branch Ducts: Perform pitot traverses for fan total air flows including traverses for hot and cold decks, for each zone in multi-zone systems and for each floor. Mark locations of pitot traverses on reduced drawings in final report.
1) Note temperature and barometric pressure. Corrections shall be made for systems operating at 5200-foot elevation.
2) After establishing total air being delivered, adjust fan speed to obtain design airflow. Check power and speed to see that motor power and critical fan speed have not been exceeded.
3) Proportionally adjust branch dampers until each has proper air volume.
4) With all dampers and registers in system open and with supply, return, and exhaust fans operating at design cfm or speed, set minimum outdoor and return air ratio.
5) After minimum outside air damper has been set for proper percentage of outside air, take another traverse of mixture temperatures. Notify the University Project Manager and note in balancing report if variation from average is more than 5 percent.
e. Adjust system with mixing dampers positioned for minimum outside air.
f. Balance terminal outlets in each control zone in proportion to each other. Use branch dampers for major adjusting and terminal dampers for trim or minor adjustment only.
g. Balance constant volume reheat systems in one mode, namely design airflow.
h. Balance constant volume dual duct systems at the boxes for full cooling and full heating air flows. Balance the fan with all the boxes on full cooling. Record the total fan supply with the boxes on full cooling.
i. Balance VAV fans by placing a certain number of the VAV boxes in full cooling mode. This number shall be equal to the system diversity and shall include boxes that are at the end of the system, that are on duct branches with high static loss and serve critical areas. With the system in this mode the fan shall be sheaved to maintain the static pressure required to control the worst case VAV box.
j. Once total design air has been balanced in branches and at outlets, verify and record the following:
1) Fan motor amperage.
2) Fan speed
3) Fan cfm.

4) Fan outlet velocity.
5) External and total static pressure.
6) Supply, return, mixed, and outside air temperatures.
7) Percent outside air under minimum damper position.
8) Static pressure across each component (intake, filters, coils, and mixing dampers).
9) Take a final duct traverse.

k. Final adjustments shall include, but not be limited to the following:
1) Adjust RPM on belt drive fans. Include sheave and belt exchange to deliver air flow within limits of installed motor horsepower and mechanical stress limits of the fan. Determine limiting fan tip speed before increasing RPM. Final fan speed setting shall allow for filter loading and shall establish proper duct pressures for operation of zone cfm regulators.
2) Replace all variable pitched sheaves with fixed pitched sheaves. This includes such devices as fan coils.
3) Adjust rpm on Direct Drive Fans:
a) For motors with speed taps, set fan speed on tap which most closely approaches design cfm. Report tap setting on equipment data sheet as high, medium, or low.
b) For motors with speed control, set output of fan at design cfm by adjusting control. Ensure the fans restart after shut down. Increase setting as required for proper setting. Mark control to indicate final setting position.
4) Terminal Boxes:
a) For variable air volume (VAV), constant volume boxes, or dual duct boxes, set regulators to provide design minimum and maximum airflow rates. Adjust thermostat to assure proper damper operation.
b) For VAV, or constant volume boxes with reheat, set regulators to provide design minimum and maximum air flow rates. Check control sequence operation to assure proper sequencing.
c) Air flow performance of boxes for both primary and secondary balance settings shall be verified by flow measuring hood measurements at diffuser outlets.

3. Fume Hood Balancing:
a. Balance fume hood exhaust fans to meet face velocity requirements. The face velocity shall be maintained at a face velocity as required by the project specific equipment, the manufacturer and coordinated with the University Project Manager and EH&S.
b. Balance hoods with the building supply and exhaust systems in normal operation, with doors and windows in typical position and hoods empty and clean. Record these conditions in report.
c. Set horizontal sash hoods at 12 inches or greater. Adjust the fan to provide the required face velocity measured at a minimum of nine centerline measurements equally spaced at sash plane using a hot wire anemometer. The average of the nine measurements shall be corrected for temperature and altitude and recorded. Place a sticker furnished by the University Project Manager at the approved sash height.
d. Raise the sash to find the height where the design face velocity is achieved. Mark this height with a second sticker furnished by the University Project Manager. If the sash height is below the acceptable working height, the hood will not pass acceptance.
e. Set vertical sash hoods with a 12-inch or greater space centered in front of the hood. If an odd number of sashes exist, the opening shall be the most distant from the exhaust point inside the hood. Adjust the fan to provide the required face velocity measured at a minimum of nine centerline measurements equally spaced at sash plane using a hot wire anemometer. The average of the nine measurements shall be corrected for temperature and altitude and recorded.
f. Move the sash to find the position where the design face velocity is achieved. Mark this position with a second sticker furnished by the University Project Manager.
g. Indicate face velocity in FPM on fume hood for record.

h. Adjust spaces with pressure gradients or directional air flow requirements to meet standards as well as designated air flows. Verification of performance shall be made with pressure gradient measurements, smoke tests in presence of the university Facilities Operations representative, or hot wire anemometer across door cracks etc. Pressure differential measurements are preferred unless gradient is too small (under 0.01 inches w.c.) by standard.
i. Hoods to be tested and balanced in accordance with ASHRAE 110 and SEFA Standards.

4. Bio-Safety Cabinets: Balance all thimble-connected Class II, A2 or A3 Bio-Safety Cabinets to meet manufacturer requirements and NSF 49.
5. Smoke Systems: Test smoke management systems per NFPA 92A.
6. Equipment Motors: Record the following information for every motor and include information with the appropriate equipment.
   a. Motor horsepower and rpm.
   b. Nameplate and measured voltage and amperage, each phase.
   c. Motor Starters and Thermal Heaters: Check for correct sizing for proper motor protection on magnetic and manual starters.
7. Building Automation System: Coordinate with Section 23 09 00. Inspect temperature control systems for proper sequence of operation and approximate calibration. Report any deficiencies. Include written certificate in balance report that temperature controls function properly.
   a. Verify proper operation of devices. Verify that all controllers are calibrated and operational.
   b. Check location of transmitters and controllers. Note adverse conditions that would affect control and suggest relocation as necessary to University Project Manager.
   c. Note settings on controllers. Note discrepancies between set point for controller and actual measured variable.
   d. Verify operation of all limiting controllers, positioners, and relays (e.g., high and low temperature thermostats, high and low differential pressure switches, etc.).
   e. Activate controlled devices, checking for free travel and proper operation of stroke for dampers and valves. Verify and note normally open (NO) or normally closed (NC) operation.
   f. Verify sequence of operation of controlled devices. Note line pressures and controlled device positions. Correlate to air or water flow measurements. Note speed of response to step change.
   g. Confirm interaction of interlock and lockout systems.
   h. Provide set-point for every hydronic and air system pressure sensor. Coordinate closely with Division 23 09 00.
   i. Provide differential pressure set-point for dirty filter replacement for each filter bank installed in the building.
8. Sound and Vibration Levels: Test and adjust mechanical systems for sound and vibration in accordance with instructions of referenced standards.
9. Provide baseline acoustical and vibration testing for all air handlers, and large exhaust fans.
10. After deficiencies are corrected, retest the systems until acceptable values are obtained.
11. Permanently mark balancing devices spray paint indicating final position. Grease markers are not permitted.

J. Report:
   1. Report Format: Standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Include information indicated on standard report forms prepared by AABC or NEBB for each respective item and system, and schematic diagrams for each system or piece of equipment to accompany each respective report form. Bind report forms complete with schematic systems diagrams and other data in reinforced vinyl three-ring binders. Provide binding edge labels with project identification and a title descriptive of contents. Divide contents of binder into following divisions, separated by divider tabs:
      a. General Information and Summary
      b. Air Systems
      c. Hydronic Systems

d. Temperature Control Systems
e. Special Systems such as fume hood exhaust systems.
f. Sound and Vibration Systems
g. Recommendations.

2. Report Contents: Provide following minimum information, forms, and data:
   a. General Information and Summary:
      1) Inside cover sheet to identify testing, adjusting, and balancing agency, contractor, and project name. Include contact names, addresses, and telephone numbers.
      2) Certification sheet containing seal, address, telephone number, and signature of Certified Test and Balance Engineer.
      3) Listing of instrumentation used for procedures along with proof of calibration.
   b. Test Data: Report shall include the following data, in addition to certified field report readings taken during the balancing and testing operations. Include required or specified reading, first reading taken, and final balanced reading.
      1) Air Handling Units and Fans: Air handling unit, fan and motor nameplate information, type, drive sheave information (as installed and changed), and final belt number and size.
      2) Air Balance for Supply, Return, Relief, and Exhaust Systems:
         a) Outlets, Inlets, Diffusers, Registers, and Grilles: Size, reading orifice size, velocity in fpm, and design and final balanced air quantity in cfm.
         b) Terminal Boxes: Design and final minimum and maximum cfm settings including fan cfm on fan powered terminal boxes.
         c) Ducts: Size, velocity in fpm, and air quantity in cfm.
      3) Hydronic Balance:
         a) Water coil size and manufacturer.
         b) Boiler and burner nameplate information and flue gas analysis. Flue gas analysis shall be copy of manufacturer's analysis report.
         c) Chiller and motor nameplate information.
         d) Cooling tower and fan motor nameplate information.
         e) Pump and motor nameplate information. Include manufacturer's pump curves.
         f) Heat exchanger nameplate information.
         g) Snow melt circuits.
      4) Record thermal protection for all motors. Starter brand, model, enclosure type, installed thermal heaters and rating of heaters, required thermal heaters and rating of heaters if different from installed shall be recorded.
      5) Include sheet that reports method of balance, project altitude, and any correction factors used in calculations.
      6) Include a reduced set of contract drawings with all terminals (VAV boxes, outlets, inlets, coils, unit heaters, fans, etc.) clearly marked and all equipment designated.
      7) Prepare list of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

3.2 TESTING, CLEANING AND CERTIFICATION

A. After cleaning, pressure tests, adjusting, and balancing are complete, each system shall be performance tested as a whole to verify that all items perform as integral parts of system, and temperatures and conditions are evenly controlled throughout building. Make corrections and adjustments as required to produce conditions indicated.

B. Provide four (4) copies of testing, adjusting, and balancing report bearing seal and signature of the TAB Engineer. The report shall be certification that systems have been tested, adjusted, and balanced in accordance with referenced standards; accurate representation of how systems have been installed; and accurate record of all final quantities measured.

C. Final Report:

1. Submit a preliminary report within 30 days of completed TAB work. Report shall include the following information.
   a. A general discussion preface section. This section shall summarize all abnormalities or problems encountered during the project and what course of action was taken. This summary should be assembled from the written progress reports described earlier, except that it will be expanded to include responses from the Engineer, the University Project Manager and Contractor regarding each problem indicated in the progress reports.
   b. Copies of correspondence if related to the performance and balance of the systems.
   c. Status of doors, windows and equipment static pressures during balance work.
   d. Reduced 11" x 17", readable, as-built drawings obtained from the University Project Manager. All devices and equipment shall be clearly labeled.
   e. Belt and sheave information, fan and motor nameplates information, full load operating voltage and amperage indicate sheave diameter as pitch diameter.
   f. Design and final actual cfm at each system terminal unit. Include terminal/size, inlet static pressure, temperature and velocities read to attain the design cfm.
   g. Overload protection for all motors shall be recorded. Starter and brand model, enclosure type, installed overload devices, original ratings, and set points (and revised device ratings and set points when application) shall be recorded.
2. Any corrective action shall be completed and the systems re-tested. The corrected system information shall be provided in the final report.
3. Final Report shall be completed within 30 days of preliminary report.

3.3 COMMISSIONING (DEMONSTRATION)

A. Upon request of the university Facilities Operations Representative, through the University Project Manager, the balancing firm shall demonstrate measured quantities of randomly selected equipment. The number of readings verified will not exceed 10 percent of the total in the report.

END OF SECTION 23 05 93

SECTION 23 07 00 – INSULATION

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Provide minimum insulation thickness as suggested in ASHRAE Standard 90A.

B. Provide removable insulation for chilled water pumps and specialty valves and fittings.

1.2 DEFINITIONS

A. Concealed: As used in this Section refers to insulation in ceiling plenums, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, unexcavated areas, and crawl spaces.

B. Exposed: As used in this Section refers to insulation that is not concealed.

1.3 QUALITY ASSURANCE

A. Composite insulation, including jackets, coverings, sealers, mastics, and wet or dry adhesives shall have a flame spread rating of 25 or less and smoke-developed rating of 50 or less, as tested by ASTM E84.

B. Elastomeric foam with a smoke-developed rating of 150 or less may be used, except in ducts, plenums, and concealed spaces that are part of the air distribution system

C. PVC fitting covers shall have a maximum flame spread of 25 or less and are exempted from the smoke spread criteria.

D. Duct liner shall comply with NAIMA Fibrous Glass Duct Liner Standard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Insulation: Identification and/or type of material from a manufacturer is as shown under each heading of 2.2 Materials, General.
      a. Manville Products
      b. CertainTeed.
      c. Rubatex
      d. Knauf
      e. Pittsburgh Corning
   2. Adhesives, Coatings, and Sealants:
      a. Foster
      b. Childers Product Company
      c. Hardcast

2.2 MATERIALS, GENERAL

A. Pipe Insulation:
   1. Glass Fiber:
      a. Manville Micro Lok AP T Plus
   2. Hydrous Calcium Silicate:
      a. Rigid, molded block, conforming to ASTM C533.

b. Asbestos-free, color-coded throughout material. Coding shall remain stable throughout rated temperature range.
c. Thermal Conductivity (k Value): 0.40 at 300 degrees F.
d. Maximum Service Temperature: 1,200 degrees F.
e. Compressive Strength: Minimum of 160 PSI to produce 5% compression at 1-1/2 inch thickness.
f. Tie wires: 16 gauge stainless steel.
g. Manville Thermo 12/Gold

3. Elastomeric Foam:
a. Flexible, cellular, molded or sheet; conforming to ASTM C534.
b. Thermal Conductivity (k value): 0.27 at 75 degrees F.
c. Maximum Service Temperature: 220 degrees F.
d. BBX, K-Flex acceptable for high temp applications to 300 deg F.
e. Connection Adhesive: Waterproof, vapor retarding, Rubatex R-373.
f. UV protective coating: Water-based latex enamel paint. Rubatex 374.
g. Insulation Tape: Elastomeric thermal insulation tape with closed-cell structure.
h. Rubatex R-180-FS/R-1800-FS,.

4. Cellular Glass:
a. Waterproof, closed cell, rigid insulating material composed of sealed glass cells conforming to ASTM C552.
b. Thermal Conductivity (k value): 0.35 at 75 degrees F.
c. Density: 8 pounds per cubic foot.
d. Water-vapor Permeability: 0.005 perm-inch.
e. Pittsburgh Corning Foamglass.

B. Field Applied Pipe and Fitting Jacketing:
1. PVC Plastic: One-piece, UV-resistant, 20-mil thick, molded type, gloss white finish with fiberglass insulation insert for fittings.
a. Manville Zeston 2000 (indoors).
b. Manville Zeston 300 (outdoors).

2. Aluminum:
a. 0.016-inch thick sheet with smooth or embossed finish, longitudinal slip-joints with 2-inch laps.
b. Sealant: Weatherproof.
c. Fitting covers: Die shaped with factory attached protective liner.

3. Canvas:
a. Plain weave cotton treated with fire-retardant lagging adhesive.
b. Weight: 6 ounces per square yard.
c. UL listed fabric.

4. Stainless Steel:
a. 0.010-inch thick, type 304 stainless steel with smooth or corrugated finish.

C. Duct Insulation:
1. Flexible Fiberglass Blanket:
a. ASTM C553, Type 1, Class B-3.
b. Thermal Conductivity (k value): 0.25 at 75 degrees F.
c. Density: 1.0 pounds per cubic foot.
d. Vapor barrier jacket: Aluminum foil reinforced with fiber-glass yarn and laminated to fire-resistant Kraft (Foil Scrim Kraft).
e. Manville Microlite.

2. Rigid Fiberglass Board: Not allowed.
3. Interior duct lining allowed only for sound attenuation at ventilation system terminal units. Insulation shall be installed only on the leaving side of the terminal box, and in quantities of less than six lineal feet.

D. Duct Jacketing:

1. Canvas:
   a. Plain weave cotton treated with fire-retardant lagging adhesive.
   b. Weight: 6 ounces per square yard.
   c. UL listed fabric.
2. Outdoor Duct Jacketing:
   a. Aluminum: 0.016-inch thick sheet with smooth or embossed finish, longitudinal slip joints with 2-inch laps.
   b. Non water-vapor retarder: Non-burning, weatherproof coating, Manville Insulkote ET.
   c. PVC plastic: 30mil thickness, UV resistant, Manville Zeston, 300 Series.

E. Duct Liner (allowed for sound attenuation only, 6 lineal feet, at leaving side of terminal units. Duct liner is not allowed in lab air supply):
1. Round Duct Liner:
   a. Rigid material, conforming to ASTM C427.
   b. Thermal Conductivity (k value): 0.23 at 75 degrees F.
   c. Noise Reduction Coefficient: ASTM C423, minimum of 0.70 based on type-A mounting.
   d. Velocity rating: Minimum of 4,000 feet per minute.
   e. Manville Spiracoustic.

F. Equipment Insulation:
1. Flexible Fiberglass Blanket:
   a. ASTM C612, Class 1.
   b. Thermal Conductivity (k value): 0.24 at 75 degrees F.
   c. Maximum Service Temperature: 450 degrees F.
   d. Density: 1.5 pounds per cubic foot.
   e. Vapor Retarder Jacket: Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft paper.
   f. Manville 812 Spin-Glass.
2. Rigid Fiberglass Board:
   a. ASTM C612, Class 1 or Class 2.
   b. Thermal Conductivity (k value): 0.23 at 75 degrees F.
   c. Maximum Service Temperature: 450 degrees F.
   d. Density: 3 pounds per cubic foot.
   e. Vapor Retarder jacket: Aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft paper.
   f. Facing: 1-inch galvanized hexagonal wire mesh stitched on one face of insulation.
   g. Manville 814 Spin-Glas.
3. Rigid Fiberglass Board (High Temp):
   a. Non-combustible, conforming to ASTM C612, Class 3.
   b. Thermal Conductivity (k value): 0.23 at 75 degrees F.
   c. Maximum Service Temperature: 850 degrees F.
   d. Density: 3 pounds per cubic foot.
   e. Facing: 1-inch galvanized hexagonal wire mesh stitched on one face of insulation.
   f. Manville 1000 Spin-Glass.
4. Cellular Glass:
   a. ASTM C552.
   b. Thermal Conductivity (k value): 0.35 at 75 degrees F.
   c. Density: 8 pounds per cubic foot.
5. Hydrous Calcium Silicate:
   a. Rigid, molded block, conforming to ASTM C533.
   b. Asbestos-free color-coded throughout material. Coding shall remain stable throughout rated temperature range.
   c. Thermal Conductivity (k value): 0.40 at 300 degrees F.
   d. Maximum Service Temperature: 1200 degrees F.
   e. Compressive strength: Minimum of 160 PSI to produce 5% compression based on 1-1/2 inch thickness.

f. Manville Thermo-12/Gold.

G. Tank Insulation:
1. Flexible Fiberglass Board:
a. Thermal Conductivity (k value): 0.35 at 200 degrees F.
b. Maximum Service Temperature: 650 degrees F.
c. Density: 3 pounds per cubic foot.
d. Vapor Retarder Jacket: Pressure sensitive, self-sealing tape lap system of white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil.
e. Manville Pipe and Tank Insulation.

H. Steam Valve Insulation:
1. Material:
a. Insulation: Fiberglass
b. Inner jacketing: Teflon coated Nomex cloth.
c. Gussets: Teflon coated Nomex cloth.
d. Outer jacketing: Teflon coated Nomex cloth.
e. Sewing Thread: Stainless steel using lock stitch with seven stitches per inch.
f. Seam Fasteners: Teflon belts with stainless steel double D-rings and Velcro tabs.
g. Terminal Ends: Teflon coated Nomex cloth flaps with Teflon coated Nomex cloth drawcord.
h. Hardware: 304 stainless steel.
i. Maximum Service Temperature: 500 degree F, wet or dry environment.
j. Secure insulation within the jacketing with stainless steel quilt pins. Secure covers with cinch belts. Teflon belts with two stainless steel D-ring fasteners.
k. Belts secured to cover with Velcro hook-and loop-fasteners.
l. Advance Thermal Corporation.

I. Fire-stop Insulation:
1. Flexible blanket, amorphous wool:
a. Thermal Conductivity (k value): 0.85 at 1000 degrees F and 1.70 at 1800 degrees F
b. Continuous use-temperature rating: 1834 degrees F
c. Melting point: 2327 degrees F
d. Density: 6 pounds per cubic foot.
e. Thermal Ceramics SF607.

J. Fixed and Removable Valve Insulation:
1. Insulate valves, strainers and other equipment on steam, condensate, and hot water lines.
2. Steam and Hot Water Valves:
a. 3 inch and larger: Insulate with removable insulation jacket.
b. 2-1/2 inch and smaller: Do not insulate unless removable type is shown to be cost effective or effect of heat loss is shown to be detrimental.
3. Removable Insulation Jackets:
a. 1 inch thick fiberglass insulation.
b. Density: 9 to 11 lb. Pcf.
c. Maximum Service Temperature: 1000 degree F.
d. Secure with stainless steel quilting pins.
e. Inner and Outer Jacket: Silicone coated fiberglass, 34 oz. per sq. yard, chemical resistant, suitable for temperatures to 500 degree F.
f. Seam Closure: Teflon coated fiberglass threads suitable for temperatures to 600-degree F. of type 20 lb. Tensile strength.
g. Fastening System: Type 304 stainless steel double D-rings with silicone coated fiberglass belts with Velcro on ends. 1-inch wide belt sewn to adjacent insulation, flanges, etc. Stainless steel wire cords, minimum 1/4 inch diameter and Teflon coated.
h. Identification: Furnish type 304 stainless steel or aluminum I.D. tag riveted to jacket with item description, location and factory number.

K. Utility Vault Pipe Insulation
1. Steam and condensate line insulation
   a. Closed-cell fiberglass
   b. All insulation surfaces shall be protected by metal jacketing
2. Chilled water supply and return insulation
   a. Closed-cell fiberglass
   b. Required insulation thickness
   c. All insulation surfaces shall be protected by metal jacketing

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

A. Overview:
1. Install insulation only after piping, ducts, and equipment have been tested and approved by the Project Manager, and after all other tests and certifications which are required by the specifications have been satisfactorily completed.
2. Continue insulation vapor barriers through penetrations except where prohibited by code.
3. Install pipe and duct insulation continuous through wall and floor openings except where the penetrated surfaces or assemblies are fire-resistance rated. Provide fire-stop insulation at penetrations of fire-rated surfaces and assemblies. Maintain fire-resistance ratings of penetrated surfaces and assemblies.
4. Install insulation on cold surfaces with a continuous, unbroken vapor seal. Insulate and vapor seal supports and anchors, which are directly secured to cold surfaces.
5. Seal all exposed raw edges of insulation with vapor retarder or finishing cement.
6. Do not use staples on vapor barrier jackets. Where staples must be used, thoroughly seal the vapor barrier penetrations with a white vapor-barrier finish. The Engineer prior to installation must approve use of staples.
7. Do not weld insulation support pins to pressure vessels.
8. Leave all insulation surfaces dry and clean, and ready for subsequent work.

B. Installation of Piping Insulation:
1. Install insulation and covers with seams in the least visible location.
2. Neatly finish insulation at supports, protrusions, and interruptions.
3. Verify piping wells and P & T taps are extended so that they will be flush with the surface of the finished insulation.
4. Insulated dual-temperature piping systems and for insulated piping conveying fluids of a temperature less than the ambient temperature: Install vapor-retardant jacket with self-sealing lap joints. Insulate the complete systems.
5. Insulated piping conveying fluids of a temperature greater than the ambient temperature: Install vapor-retardant jacket with self-sealing lap joints. Bevel and seal ends of insulation at equipment, flanges, and unions.
6. Piping conveying cold fluids: Insulate continuous through hangers. Install rigid insulation inserts at pipe hangers and supports. Butt inserts tight to insulation. Apply a wet coat of vapor-barrier lap cement on butt joints and seal the joints with three-inch wide vapor-barrier tape or band.
7. Install calcium silicate insert between support shields and piping for piping 1-1/2 inches and larger. Inserts shall not be less than the following lengths:

Pipe Size Inches	Insert Length Inches
1-1/2	6
2 through 9	9
10 through 14	12
16 through 24	18

8. Exposed piping in mechanical equipment rooms and exposed piping within 10 feet of the finished floor in finished spaces: Install PVC jacket and fitting covers or aluminum jacket.
9. Exterior applications: Install PVC jacket and fitting covers or aluminum jacket over insulated pipe, fittings, joints, and valves. Locate jacket seams on bottom side of horizontal piping. Cover all valves, flanges, unions, accessories, and fittings with aluminum jacket. Seal jacket watertight and secure with lock type aluminum bands.
10. Refrigerant piping insulated with elastomeric insulation: Seal joints with elastomeric sealant made by same manufacturer as the insulation. For outdoor locations, paint insulation white or silver. Paint shall be compatible with the insulation.
11. Piping under concrete slabs on grade: Spiral wrap insulation with Protecto Wrap 200 coating with 50% overlap. Lay the insulated and wrapped piping on a 3-inch bed of sand and cover with 3 inches of sand all around.

C. Installation of Blanket Insulation:
1. Apply insulation with edges tightly butted. Overlap facing at least two inches at joints. Seal joint in vapor seal with fire-retardant adhesive. Secure insulation to duct with approximately four-inch wide fire-retardant adhesive spaced at 8 inches on center
2. Ducts Exceeding 30 Inches in Width: Install mechanical fasteners at 18 inches on center for the underside insulation in addition to the adhesive. Cut off the protruding ends of the fasteners flush after speed clips are installed and seal with vapor tape or mastic.
3. Insulated ducts conveying air of a temperature less than the ambient temperature: Install vapor retardant jacket. Seal jacket seams and penetrations with UL listed tape or vapor retardant adhesive.
4. Insulated ducts conveying air of a temperature greater than the ambient temperature: Bevel and seal ends of insulation where service access is required.
5. Ducts Subject to Physical Abuse in Mechanical Equipment Rooms and Finished Spaces: Install PVC or aluminum jacket.
6. Outdoor Applications: Install insulation with a weather protection jacket.

D. Installation of Equipment Insulation:
1. Apply insulation as close as possible to equipment. Groove, score, and bevel insulation as necessary to achieve a tight fit. Secure insulation to equipment with studs, clips, pins, adhesive, wires, or bands as appropriate for the application. On cold equipment, do not use securing methods that penetrate the vapor barrier
2. Fill joints, cracks, seams, and depressions with bedding compound. Form smooth surfaces. On cold equipment, use vapor retardant cement.
3. Insulated dual-temperature equipment and for insulated equipment that contains fluids of a temperature less than the ambient temperature: Install vapor retardant jackets.
4. Insulated equipment that contains fluids of a temperature greater than the ambient temperature: Install jacket with or without vapor barrier.
5. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket.
6. Do not insulate over nameplates, ASME stamps or UL labels. Bevel and seal insulation around nameplates and labels.
7. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation so that it can be easily removed and replaced without damage.

E. Installation of Insulation on Fittings and Valves:
1. Factory premolded one piece PVC insulated fitting covers: Use factory precut insulation applied to the fitting using two layers for pipe temperatures above 250 degrees F or below 35 degrees F, single layer insulation is acceptable between 35 degrees F and 250 degrees F. Tuck the ends of the insulation snugly into the throat of the fitting and the edges adjacent to the pipe covering, tufted and tucked in, fully insulating the pipe fitting. Covers shall overlap the adjoining pipe insulation and jackets, and on cold pipes seal at all seam edges with vapor barrier adhesive. Seal circumferential edges of all covers with pressure sensitive vinyl tape. The tape shall overlap the jacket and the cover at least one inch.

2. Where PVC covers are prohibited: Use as an alternate one of the following methods: aluminum covers, one coat insulation cement, premolded fiberglass fitting covers, or mitered segments of pipe insulation. Finish for non-PVC or aluminum shall be glass fabric embedded in fire retardant mastic lapped 2 inches over piping insulation. Finish with second coat of mastic. Mastic shall be vinyl acrylic mastic Childers CP-11 for hot piping and shall be Childers CP-30 or Fosters 30-35 or equal for cold piping.
3. Valves may be insulated with sections of fiberglass pipe insulation complete with All Service Jacket. Raw ends shall be coated with vinyl acrylic mastic Childers CP-11 for hot piping or shall be coated with vapor barrier mastic Childers CP-30 or Fosters 30-35, or equal for cold piping.
4. Insulate balancing cocks, strainer drains, hose bibs, and equipment requiring periodic maintenance with segmental insulating with an integral vapor barrier. Insulation and vapor barrier shall be easy to remove and replace.

F. Installation of Engine Exhaust and Breeching Insulation:
1. Install calcium silicate insulation on engine exhaust and breeching.
2. Install two layers of calcium silicate. Tightly butt and stagger joints. Secure with 16-gauge galvanized or stainless steel wire, or 1/2-inch by .015-inch galvanized steel bands. Install supports 12 inches maximum on center.

G. Installation of Tank Insulation:
1. Wrap insulation around tank and secure with self sealing longitudinal laps and butt strips, or all-purpose jacket with outward clinch expanding staples on maximum 4-inch centers. Remove two segments of insulation to provide for lap.
2. Cut circular sections for top and bottom of tank and insert inside of tank wrap.
3. Seal all longitudinal and circumferential joints with 3 inches wide pressure sensitive tape.
4. Apply vapor retarder mastic to all joints and staples.

H. Installation of Fire-stop Insulation:
1. Install per listing.

I. Installation of Steam and Hot Water Valves Insulation:
1. Provide custom fabricated insulated jackets for all valves and fittings.
2. Fabricate inner and outer jacketing for exposure to steam leaks on medium and high-pressure steam systems. Jacketing shall retain full flexibility after an exposure from minus 50 degrees F to plus 500 degrees F.
3. Construct and install covers to shed water. Locate closing seams at the gravitational bottom. Closely contour removable covers, ensure neat appearance and thermal performance. Individual covers or cover sequents shall not weigh more than 60 pounds.

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the commissioning process for facilities. Commissioning is intended to ensure the quality and functionality of installed building systems and assemblies, optimize building system performance, ensure that owner and occupant requirements are met, and aid in the orderly transfer of systems to the university.

B. Commissioning is required on all projects. Utilization of outside resources will be decided on a project-by project basis with approval of the university Facilities Operations through the University Project Manager. If no outside resources are utilized, then the engineer will complete the commissioning of the project.

C. Systems to be commissioned should include LEED Energy and Atmosphere minimum of fundamental commissioning prerequisites and should consider LEED Enhanced Commissioning work with the University Project Manager and LEED rating for new building, addition or major renovation.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Commissioning Authority shall:
1. Coordinate and direct each step of the commissioning process, and recommend acceptance or non-acceptance to the university's representative.
2. Assist in clearly identifying problems encountered in testing the functional performance of the mechanical system and cooperatively assisting in the development of the solutions to those problems. These potential problems may involve mechanical design, mechanical installation, mechanical equipment, controls devices, controls installation, controls software, etc.
3. Coordinate directly with each sub contractor with respect to their responsibility and contractual obligations.
4. Obtain, assemble and submit commissioning documentation.
5. Attend periodic on-site commissioning activities.
6. Develop the commissioning plan and schedule.
7. Develop the commissioning checklists and functional performance test plans. If there is a conflict between the requirements of the engineer and those of the Commissioning Authority, and the conflict cannot be resolved, the requirements of the Engineer shall have precedence.
8. Coordinate the installation verification inspections.
9. Review the control documentation and interface with other systems.
10. Review the operation and maintenance information and as-built drawings provided by the various sub-contractors and vendors.
11. Note any inconsistencies or deficiencies in the system.
12. Enforce system compliance and recommend modifications to the system design that will correct or enhance the system performance.
13. Coordinate the university's representative for witnessing of the tests.
14. Be present during start-up activities to assist and witness the execution of start-up checks and procedures.
15. Monitor the performance of the Test, Adjust and Balance contractor.
16. Review the accuracy and calibration of any instrumentation utilized for the functional performance testing and point to point testing.
17. Direct the functional performance testing.
18. Track commissioning deficiencies until correction.
19. Prepare and submit the commissioning reports.
20. Provide an 8 hour training class for up to six maintenance personnel.
21. The Commissioning Authority shall include in the commissioning bid.

a. All required costs to identify the design and construction problems as they relate to the mechanical system functional performance and acceptance.
b. Assistance in the process of proposing solutions to mechanical system functional performance and acceptance problems.
c. Assistance in implementing the solution for a mechanical system functional performance and acceptance problem.

22. In the event that any one of the contractors or engineers are unwilling or unable to participate in the commissioning process and/or the resolution of problems identified in the commissioning process, that portion of the commissioning process shall be discontinued until such time that contractor/designer participation and problem resolution is resumed. The Commissioning Authority shall notify the university's representative in writing of:
    a. The portion of the commissioning process in question.
    b. The problem being encountered with the system.
    c. The problem being encountered with the contractor/designer.
    d. The approximate costs encountered in attempting to get cooperation and projected costs in completing that portion of the commissioning process.

B. Smoke Management System Commissioning Authority:
1. Inspect the following:
    a. Automatic dampers
    b. Fans
    c. Controls diagrams
    d. Marking & identification
2. Verify the following:
    a. Vestibules
    b. Fans
    c. Detection devices
    d. Dampers
    e. Inlets and Outlets
    f. Smoke barriers
    g. Standby power
    h. Control action & Priorities
    i. Controls
    j. Response time
3. Reports: Provide the following reports and forms:
    a. Verification plan
    b. Testing & Validation Forms
    c. Daily Log & Reports Forms
    d. Non-Compliance Forms

C. Design Engineer:
1. Provide the Basis of Design Document (BoD) for individual systems and for overall building systems integration to meet the OPR. The Basis of Design Document shall use narrative descriptions, lists, schematics or other means necessary to clarify the design team's approach to:
    a. Building energy conservation
    b. Achieving target sustainability ratings
    c. Optimization of system and equipment efficiency at partial loads
    d. Ventilation requirements
    e. Basis of selection for primary heat distribution/removal methods
    f. Building pressure control
    g. Standards and guidelines compliance
    h. Redundancy considerations
    i. Product selection

    And shall specify:
    j. Specific indoor/outdoor design conditions
    k. Key heat load calculation inputs

l. Equipment full load operating requirements
m. Other criteria relevant to OPR requirements

2. The design engineer shall be responsible for the observations and checklists for the Installation Verification as defined in Part 3 of this Section.
3. Additional calculation and investigation of design adjustments needs by the engineers as defined by the Commissioning Authority.
4. Participate in the resolution of potential design concerns as discovered during the commissioning process.

D. Contractor:

1. The contractor shall be responsible for the Pre-functional Testing, a start-up procedure performed prior to balancing as defined in Part 3 of this Section.
2. The contractor shall be responsible for providing any technical personnel required for physical operation, testing and simulation of control sequences for each piece of controlled equipment as required by the Commissioning Authority during the Functional Performance Testing. This shall include chiller service personnel, boiler service personnel, the temperature control engineering and technical start-up crew, mechanical contracting service personnel for miscellaneous equipment, balancing contractor personnel, fire alarm contractor personnel, lighting contractor personnel, security system contractor personnel, and electrical contractor personnel. .. To the extent possible, these personnel will be scheduled
3. Additional calibration and adjustment of the mechanical equipment included in each mechanical system for proper operation under actual operation as defined by the Commissioning Authority.
4. Additional testing, calibration, adjustments, tuning, and minor adjustments to the temperature controls system sequences for proper operation under actual operations defined by the Commissioning Authority.
5. Additional testing, calibration and adjustment of the mechanical water and airflow of each mechanical system for proper operation under actual operation as defined by the Commissioning Authority.

E. The University shall:

1. Develop the Owner's Project Requirements (OPR) document in the pre-design phase with the assistance of the Commissioning Authority, and input from the design team, the end-user, and the O&M representative(s). Input shall be obtained using accepted methods such as questionnaires, surveys, workshops, etc. The OPR shall serve as the basis for the Basis of Design Document developed by the design team. The sections of the OPR pertaining to mechanical systems should detail:
   a. Minimum and maximum interior temperature requirements by space or room number.
   b. Interior air quality and humidity requirements by space type.
   c. Specific building or room pressurization requirements
   d. Projected occupancy levels and usage schedules
   e. Control system preferences or exclusions
   f. HVAC systems and equipment preferences or exclusions
   g. Specific standards compliance requirements (ie. ASHRAE, JCAHO, NFPA, etc.)
   h. Mechanical system requirements with respect to performance, compatibility, interoperability, redundancy, flexibility, or expandability
2. Appoint and schedule the university's representatives to participate in commissioning process.
3. Advise Commissioning Authority regarding any changes in the Owner's Project Requirements (OPR), such as building occupancy, usage, or functional requirements.

1.3 DEFINITIONS

A. Definition of Terms:

1. OPR (Owner's Project Requirements): a document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project oals, verifiable and quantitative performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is used as a basis for project design, commissioning

activities, and acceptance criteria. The OPR should be a living, up-to-date document that reflects any changes made or approved by the owner throughout the design and construction phases.

2. Basis of Design (BoD) Document: A document developed by the architect/engineer in the design phase based on the Owner's Project Requirements (OPR). The BoD describes the technical approach planned for the project as well as the design parameters to be used. The BoD translates OPR requirements into specific building components, systems, and control strategies and explains the justification for their selection. This document allows for necessary changes or modifications to take place in the design phase, and establishes requirements for the testing phase of project commissioning.
3. Installation Verification: This initial portion of the commissioning process includes observations and punch-list recorded and performed by the Engineer to ensure that all equipment is installed in accordance with the specifications and drawings. The Commissioning Authority shall overview this process.
4. Pre-functional Testing: This portion of the commissioning process involves primarily the test and balance and startup personnel to ensure that individual pieces of equipment are capable of performing in accordance with the specifications, drawings, and manufacturer's requirements. This is documented with a pre-functional checklist provided and completed by the contractor. The Commissioning Authority shall overview this testing.
5. Functional Performance testing: This portion of the commissioning process involves dynamic tests that ensure all mechanical systems function in accordance with design intent as defined in the BoD. The tests are dynamic and on-line and test the systems through all possible modes of operation.
6. Calibration: To check or adjust the graduation of a quantitative measuring instrument against a known standard.
7. Adjustment: To change the speed, flow, position, signal, or level of any piece of mechanical equipment.
8. Tuning: To adjust for maximum performance.
9. Minor Adjustment: To add, subtract, or change various parameters included on the operation of logic of a mechanical system or systems in order to improve or optimize operation performance. This refers only to the specified performance logic. Difficulties encountered in accomplishing a minor adjustment shall not be used to define a minor versus a major adjustment.
10. Major Adjustment: To fully change the specified operation logic of a mechanical system or systems. This refers only to the specified performance logic. Difficulties encountered in accomplishing a minor adjustment shall not be used to define a minor versus a major.
11. System Component or System Element: A single piece of mechanical equipment such as a pump, fan, chiller, boiler, coil, etc. that when combined together through piping or ductwork will comprise a "System".
12. System: A combination of system components that allow the manufacturer or distribution of conditioned air or water from one location to another.
13. The commissioning process is a joint team effort to ensure that all mechanical equipment, controls, and systems function together properly to meet the design intent of the Engineer and to document system performance parameters for fine-tuning of control sequences and operation procedures.
14. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, training and performance testing. Testing and balancing, controls and training are addressed in other sections of the Specifications.
15. The commissioning described herein, in not intended to supersede or replace the normal system startup by the contracting team, observations by the design team or balancing by the test and balance contractor.
16. Commissioning Process: In as much as possible, the commissioning process shall occur during the construction of the project for all portions of the mechanical systems that are scheduled to be complete at the opening day. This is intended to:
    a. Reduce as much as possible any duplication of work or testing for the contractor.
    b. Identify and solve any potential mechanical system design or construction problems as they relate to functional performance, prior to opening day.

17. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. Evaluate the following equipment and systems:
    a. Hydronic distribution systems.
    b. Air handling and air distribution systems.
    c. Domestic hot water systems.
    d. Variable frequency drives.
    e. Fire protection and suppression systems.
    f. Exterior switches and transformers.
    g. Electrical unit sub stations, switch gear, distribution transformers, distribution panelboards, and branch panelboards.
    h. Lighting systems.
    i. Motor control centers.
    j. Stand-by power systems.
    k. Building automation systems, hardware, software, and documentation.
    l. UPS systems.
    m. Glazing.
    n. Insulation.
    o. Indoor air quality.
    p. Building and special room pressurization.
    q. Computer room air conditioning systems.
    r. Fume hoods and special exhaust systems.
    s. Security systems.
    t. Fire alarm systems.
    u. Lightning Protection systems.
    v. Energy metering:
        1) Steam
        2) Chilled water
        3) Electric
    y. Building Envelope

B. Commissioning Team:
1. The commissioning team shall be made up of the:
    a. Commissioning Authority
    b. Representative of the University
    c. Design Engineer
    d. Design Architect
    e. Construction Trades (specialty contractors)
2. The trades represented on the commissioning team will include:
    a. General Contractor
    b. Mechanical Contractor
    c. Electrical Contractor
    d. Building Automation System Contractor
    e. Fire Alarm System Contractor
    f. Test, Adjust and Balancing
3. The lead tradesman for each trade who will actually perform or supervise the commissioning work is to be designated as the representative to the commissioning team.
4. Responsibility for various steps of the commissioning process will be divided among the members of the commissioning team, as described in this section.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Commissioning Process:
   1. Meetings:
      a. Scope Meeting: Early in the construction process, a commissioning scope meeting involving all members of the commissioning team shall be held at a time and place designated by the University Project Manager. The purpose of the meeting will be to familiarize all parties with the requirements of the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
      b. Progress Meetings: During the course of the project, the Commissioning Authority shall conduct monthly commissioning meetings during the initial 75% of the project. During the final 25% of the project construction, the Commissioning Authority shall conduct weekly meetings.
   2. Reports:
      a. General:
         1) The Commissioning Authority shall record and maintain detailed testing data. The data record shall be comprehensive and concise.
         2) All data must be recorded as soon as possible during the course of testing,
         3) All documentation shall have the date, time, and names of persons participating in the inspection and testing.
         4) All test instruments shall be documented for valid calibration.
         5) The engineer and Commissioning Authority must approve the recording work sheets, inspection checklists, and performance testing plans. Approval must occur prior to the start of Functional Performance Testing.
      b. Daily Commissioning Report Logs:
         1) The Commissioning Authority shall provide daily report logs to be included in the final report.
         2) The daily logs shall record the Commissioning Authority personnel and event summaries of meetings, conversations, tests, failures, solutions, procedures and successes.
      c. Functional Performance Test Plans, Tables and Checklist:
         1) The Commissioning Authority shall prepare detailed test plans with associated checklists to organize and document the Functional Performance Testing.
         2) A separate test plan is required for each device or control sequence.
         3) A separate checklist is required for each of the equipment/systems.
         4) Provide testing tables for large quantities of repetitive test events such as outside air volumes, VAV box close-offs, valves, etc.
      d. Final Report:
         1) The Commissioning Agent shall prepare and submit to the university's representative a final report after completion of the commissioning.
         2) The report shall verify performance of HVAC equipment and systems.
         3) Documentation any field modifications to the testing process and why these modifications were made.
         4) The organizations of the final mechanical systems commissioning report shall be as follows:
            a) Executive Summary of each mechanical system and problems encountered and resolved.
            b) System Overview summarizing the system design.
            c) Commissioning Plan.
            d) Post Commissioned Controls Sequences and Points Lists.
            e) Prefunctional Testing Checklists.
            f) Functional Testing Procedures and Results.
            g) Smoke Control Testing Scenarios and Results.
            h) Appendix of letters, memo and notes occurring during the commissioning process.
         5) Final report in a PDF format with searchable text.

3.2 TESTING, CLEANING AND CERTIFICATION

A. General Requirements:
   1. All systems and system components shall be tested in presence of Commissioning Authority (and the engineer, if desired by the engineer) to demonstrate compliance with specified requirements. To minimize the time of commissioning, contracting and engineering team members, testing shall be done in seasonal single blocks of time insofar as possible.
   2. The contractor shall notify the Commissioning Authority fourteen (14) days prior to scheduled Functional Performance Tests, of the scheduled completion date of the Installation Verification and Pre-functional Testing.
   3. All testing shall be conducted under specified design operating conditions as approved by Commissioning Authority and engineer.
   4. All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each subsystem, followed by entire system, followed by any inter-ties to other major systems.
   5. All special testing materials and equipment shall be provided by contractor. This includes, but is not limited to balancing readout and adjustment tools.
   6. Provide one copy of all test reports and records to Commissioning Authority.

B. Procedure and Test Documentation:
   1. Within sixty (60) days prior to startup of the mechanical system, the Commissioning Authority shall prepare and submit to the university's representative and engineer for review, descriptions of the test procedures which the contractor will perform to demonstrate conformance of completed mechanical systems to the plans and specifications.
   2. The decision of the Commissioning Authority and engineer upon acceptability of test procedures shall be final. In the event of an unresolved conflict between the Commissioning Authority and engineer, the engineer's decision shall have precedence. However, in no case shall such decision excuse the contractor from fulfilling the requirements of commissioning as described in this section.

C. Installation Verification Recommendations:
   1. All systems and system components shall be checked and verified that they have been installed according to the drawings and specifications, and that all connections have been made correctly.
   2. Each system of interactive system components shall be observed and verified that it is ready to function as specified.
   3. Verification of complete and proper installation shall be completed prior to starting Component Performance Tests.
   4. The Installation Verification shall be documented in a checklist format for each system/piece of equipment. Each checklist shall be dated and initialed by the engineer, mandatory.

D. Pre-functional Testing Requirements:
   1. All system components shall be checked to verify that they have been installed properly and that all connections have been made correctly. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, calibration, control sequence or other conditions which may cause damage.
   2. Verify that test, meter readings and specific electrical characteristics agree with those required by equipment or system manufacturer.
   3. All discrete elements and sub-systems of system components shall be adjusted and shall be checked for proper operation. Verify wiring and support components for equipment are complete and tested.
   4. The Pre-functional Tests shall be documented in a checklist format for each system and each piece of equipment. Each checklist shall be dated and initialed by the contractor, mandatory.

E. Functional Performance Testing Requirements:
   1. The Functional Performance Testing portion of the commissioning process shall begin after the installation of the HVAC equipment and systems, along with related equipment, systems, structures, and areas are complete.

2. A Functional Performance Test shall be performed on each complete system. Each function shall be demonstrated to satisfaction of the Commissioning Authority on a paragraph-by-paragraph basis of the written test procedure, developed to demonstrate conformance to requirements of contract specifications and the Basis of Design Document.
3. Each functional Performance Test shall be witnessed and signed off by the Commissioning Authority and contractor (and the university's representative and engineer if requested) upon satisfactory completion.
4. The Functional Performance Testing Program shall be conducted in accordance with prior approved procedures and shall be documented as required hereinafter.
5. The Commissioning Authority shall notify the the university's representative, the contracting team, the architect, and the engineer at least two weeks prior to date of scheduled Functional Performance Tests. Schedule each of the seasonal Functional Performance Test periods over a single block of days. The schedule seasonal Functional Performance Tests shall be based on the construction completion schedule. Further communication to the university representative, architect or engineer concerning the Functional Performance Testing schedule and changes to that schedule due to construction delays or coordination conf1icts shall not be required unless the noted parties have expressed an interest in writing in attending the testing.
6. Mechanical System Tasks: Verify that the total HVAC mechanical system is performing to provide conditions all possible modes of operation as outlined in the Basis of Design Document (provided by the engineer). The Functional Performance Testing procedures shall statistically represent all operating characteristics of all mechanical equipment and systems, including:
    a. Air handling and ventilation systems operation including exhaust fans, heat pumps, and fancoils.
    b. Chilled water system operation including chillers, pumps and controls.
    c. Condenser water system operation including cooling towers, pumps and controls.
    d. Heating water or steam system operation including boilers, pumps and controls.
    e. Ventilation systems operation including air handling systems, exhaust fans, supply fans, makeup air systems and controls.
    f. Terminal unit operation such as variable air boxes, fancoils, and heat pumps.
    g. Pressurization system operation.
7. Building Automation System Tasks: Verify that the total building automation system control system is performing to provide conditions through all possible modes of operation as outlined in the Basis of Design Document (provided by the engineer). The Functional Performance Testing procedures shall address all operating characteristics of a statistical representation of control system equipment, sequences, and instrumentation calibration. Include a point-by-point check to verify connectivity and control.
8. Test and Balance (TAB) Verification Tasks: Verify TAB readings for the approximate quantities of the following:
    a. 50% of Fan flows.
    b. 50% of Pump flows.
    c. 50% of Outside air volumes.
    d. 50% of Equipment pressure drops.
    e. 10% of the Supply (maximum and minimum primary air) return and exhaust diffusers, registers, and grilles.
    f. 10% of Hydronic flows.
    g. 10% of Balancing valve/damper settings.
    h. 10% of VAV box setups.
    i. 10% of Coil pressure drops
    j. If more than one-fifth of these readings differ from the documented TAB reading by more than 15 percent, then the TAB for the failed system shall be repeated in entirety.

3.3 COMMISSIONING (DEMONSTRATION)

A. The Commissioning Authority shall conduct a customized 8 hour training class for the university's engineering personnel in problem solving techniques with respect to the commissioned installation. This Commissioning Authority training does not reduce or exclude the training specified in other specification

sections, although portions of other specification sections, although portions of other specified training may be included as a part of the Commissioning Authority training. This problem solving class shall focus on the following:

1. Present the mechanical system design as a whole, integrated unit.
2. Point out the unique qualities of the installed mechanical system.
3. Provide insights into how to solve system-wide, multi-faceted problems.
4. Identify a variety of resources available to assist with problem solving.
5. The problem solving class is not intended teach day to day maintenance of parts and/or systems, establish emergency procedures, or "quick fix" problem solving approaches.

END OF SECTION 23 08 00

SECTION 23 09 00 - INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. These standards are minimum university requirements only. They are designed to clarify the university needs. They are not intended as a substitute for design services. Consultant shall provide a complete design and specification for the Building Automation Systems (BAS). This section may be referenced or portions copied and inserted into the specifications to clarify the university requirements. However, the design and specifications are the responsibility of the consultant not the university.

B. The Building Automation System (BAS) shall be a complete and fully integrated, microprocessor based BAS for control of HVAC and Building Environmental Processes.

C. The BAS shall interface with the lighting control system to schedule the HVAC system occupancies.

D. The Building Automation System applies only to the University of Colorado Anschutz Medical Campus. Contact the University Project Manager for Building Automation information regarding the University of Colorado Denver applications.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. The engineer shall clearly specify responsibilities between the BAS contractor, the TAB contractor the terminal box manufacturer and all other sections to provide a complete system that is installed without overlap.

1.3 SUBMITTALS

A. General:
1. All submittal items in this section are in addition to Division 1.
2. Submittals shall be complete, with detailed information on all items provided.
3. All submittal requirements specified shall be provide as a single bound package. Provide six (6) submittal copies or the amount specified in Division 1, whichever is greater.

B. Submit AutoCAD (or AutoCAD compatible through DXF conversion) generated schematic in hardcopy and electronic media for the entire control system, for review and approval before work shall begin. The hardcopy drawings shall be submitted on 8-1/2” x 11” or 11” x 17” sheet with drawings information sized such that all drawing information is legible. The submittal drawings shall include the following:
1. Communications:
    a. Provide a one-line diagram depicting the system architecture complete with a communication riser and peripheral devices.
    b. Provide a tabular listing of locations of controlled equipment, communications and network wiring layout, and panel locations with unit communication address identifiers.
2. Point-to-point wiring diagrams for each HVAC system accurately depicting:
    a. Complete termination and configuration of all wiring and pneumatics. (This includes termination points for wires that are terminated on equipment supplied by others.)
    b. all temperature controls located on a schematic diagram of the controlled HVAC system
    c. start-stop wiring for each piece of equipment
    d. equipment interlocks
    e. wiring terminal numbers
    f. any special connection information required for properly controlling the mechanical equipment.
3. Panel interior and panel face layouts.

C. A bill of material reference list with drawing tag identifiers, application description, manufacturer, complete model number, and quantity.

D. Identify all deviations from this standard and project documents.

E. Provide written sequences of operation which shall define all modes control strategies.

F. The submittals shall include manufacturers catalog data describing each item of control equipment or component provided and installed for the project.

1.4 WARRANTY

A. The BAS 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 university accepts the system. The warranty shall include 24 hour per day, 7 day per week emergency problem response and all standard service contract preventative maintenance items (i.e. sensor calibration, linkage adjustment, etc.). An emergency service number shall be provided to the university. Response shall be within four (4) hours to the phone call.

B. Provide factory trained technicians familiar with the installation for emergency warranty service.

C. Upgrades: Include all controller firmware and software updates for the installed system version at no additional cost to the system the university during the warranty period.

D. Tuning: Include seasonal fine-tuning of PID loop parameters and other control parameters to provide an optimized control system to the university.

1.5 QUALITY ASSURANCE

A. Installation:
1. The control system shall be furnished, engineered, and installed by the BAS manufacturer's local office.
2. Certain wiring and pneumatic installation may be performed by the BAS installer/manufacturer's approved subcontractor under the direct supervision of the BAS installer/manufacturer's field management.

B. Control system components shall be new and in conformance with the following applicable standards for products specified.
1. American Society for testing and materials, ASTM
2. Institute of Electrical and Electronic Engineers, IEEE
3. National Electrical Manufacturers Association, NEMA
4. Underwriters Laboratory, UL 916
5. Underwriters Laboratory, UL 855 (Smoke Control Only)
6. FCC Regulation, Part 15, Section 156
7. National Fire Protection Association, NFPA
8. Applicable Building Codes

1.6 SYSTEM DESIGN REQUIREMENTS

A. Campus Building Automation System Design Intent.
1. Provide a single vendor, stand-alone Building Automation System (BAS) within each new or retrofitted building. Integrate the stand alone systems via the campus BAS data network.
2. Systems shall be designed to be BACnet compatible.
3. System shall be designed as an effective easy to use tool to operate, control, monitor and alarm mechanical equipment.

4. The system shall include all DDC controllers, sensors, valves, actuators, dampers, transmission equipment, software, local workstations, local panels, installation, setup, engineering, supervision, acceptance testing, training, and warranty necessary for a complete operable system.
5. The BAS shall be a full control system designed to control terminal equipment as well as main systems.
6. Each building and or renovation project shall provide adequate devices for monitoring and operating the BAS.
7. Each building shall include one or more BAS workstations to, based on password, allow full access to system configuration and monitoring.

B. System Architecture:
1. The BAS control system architecture shall be comprised of four levels of DDC controls devices.
   a. Level 1: The first level is the system instrumentation component devices that includes but is not limited to sensors, valves, actuators, switches, relays, and transducers.
   b. Level 2: The second level includes the terminal equipment DDC controllers with specific applications for control of terminal units such as VAV boxes, fan coils and unit heaters.
   c. Level 3: The third level is comprised of general application DDC controllers for control of large primary mechanical systems such as air handling systems, heating hot water systems and chilled water systems. This level also performs system networking functions.
   d. Level 4: The fourth level consists of a file server, workstations and other devices that provide access, programming and setup tools, database management and other functions.
   e. Provisions for expansion of all levels of the DDC system shall be provided with each project such that a need for future "gateway" or "repeater" expansion hardware and software is not required.
2. Alternates:
   a. Variations from this general outline should meet the following functionality and be approved by the university.
   b. Non-intelligent slave panels may be utilized only to expand the controller point capacity for control of a single HVAC system, or specified monitoring not requiring control logic.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved BAS Installers/Manufacturers:
1. University of Colorado Anschutz Medical Campus: Siemens Building Technologies
2. University of Colorado Denver: Contact the University Project Manager

2.2 SYSTEM AND CONTROLLERS

A. All systems shall be configured and designed to be stand-alone.

B. All outputs including all outputs attached to terminal equipment controllers and special applications shall be directly commandable by the system operator. Any application that has outputs that can not be commanded by the operator shall not be accepted.

2.3 Terminal Equipment Controllers

A. Terminal Equipment Controller Hardware
1. General:
   a. Each terminal equipment controller shall be a stand-alone DDC controller designed specifically for terminal unit control such as VAV boxes, fan coil units, heat pump units or similar application.
   b. The controller shall execute local control sequences, independent of a network controller or workstation.

c. All controllers shall preserve setup and programming from a loss of power for a minimum of 7 days.

2. Programs:
   a. The control program shall reside in the terminal equipment controller.
   b. The default data base, i.e. setpoints and configuration information, shall be stored in EEPROM or other non-volatile memory.
3. Stand-Alone:
   a. Controllers that share processing with a "master controller" shall not be acceptable.
   b. After a power failure the terminal equipment controller must run the control application without having to contact another controller..
4. Communications:
   a. Communications to the general application controller shall maintain the specified network throughput speed specified in the network controller hardware section.
5. Isolation:
   a. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 3 feet.
6. Connections:
   a. All electrical connections shall be made to a combination terminal strip and base assembly.
   b. To insure long term reliability, all electrical terminations shall be screw type.

B. Terminal Equipment Controller Software:
1. Controllers shall be provided with the capabilities required by the application.
2. Each input, output or calculation result shall accessible from the terminal equipment controller communication port, application controllers and workstations.
3. Controllers that require an EPROM burn to make permanent changes to the software configuration shall not be acceptable.
4. All outputs for all controlled devices shall be directly commandable from the general application or network controller and from any workstation.
5. Global commanding of outputs and setpoints shall be available to command any number of similar terminal equipment controller outputs to the same position with a single command.
6. Terminal device controllers that do not allow separate space heating and space cooling setpoints to be configured shall not be accepted. This includes setpoint dial applications.

2.4 GENERAL APPLICATION CONTROLLERS

A. Hardware
1. General
   a. The controller shall support all of the standards for the front-end software such as trending, alarming, etc.
   b. The general application controllers shall be a local control loop microprocessor-based controllers installed at each mechanical system; (i.e., air handling units, heating plants, chiller plants, etc.).
   c. The controller provides uplink and downlink communications, polling and other supervisory functions for terminal equipment controllers.
   d. Mechanical systems in close proximity with a small number of physical inputs and outputs may be combined in controllers with modular input output layouts.
   e. The controller shall be a true no-host system that does not require a PC or "Host" computer to perform any control functions or communication.
   f. Each controller shall be addressable by a workstation or a portable service tool.
   g. Non-intelligent slave panels may be utilize only to expand the controller point capacity for control of a single HVAC system, or monitoring without control logic.
   h. Self Diagnostics: The controller shall contain in its program, a self-test procedure for checking communications and, verify the functionality of the CPU memory.
   i. All equipment located on the roof shall be provided with an extra data drop for laptop connection. Locate roof mounted equipment in conditioned enclosures.

2. Each controller shall be provided with the memory capacity to store 1000 data samples for each physical analog point and 100 data samples for each physical digital point.attached to it (including all expansion boards) and 400 data samples for each terminal equipment controller attached. This shall be in addition to the memory needed for all other functions of the panel.
3. Power Loss/Restart: The controller shall be tolerant of power failures. The memory shall be nonvolatile or unit shall hold memory for a minimum of four hours.
    a. Automatically and without operator intervention, the controller shall execute these restart procedures:
        1) Come on line
        2) Update all monitored functions
        3) Implement special building start-ups strategies as required
        4) Resume operation based on current time and status
    b. Controllers with batteries shall provide an alarmable point to the front end workstations when the batteries need to be replaced.
4. Network:
    a. Each general application controller shall connect to the campus Ethernet system.
    b. Multiple system workstation operators shall be able to access the controller simultaneously. Systems which do not provide multi-tasking, multi-user operating systems shall not be acceptable.
    c. Communication speed of each network shall have a maximum 10 second end-to-end throughput from a Level 1 device input to a Level 1 device output, anywhere in the system. Provide a system configuration that will maintain this minimum throughput speed during trend collection, recovery from power outages, and monitoring of multiple mechanical systems. Strategies to limit traffic shall not interfere with control or system monitoring.
    d. Uploading trends shall not interfere with control or monitoring operations
5. Isolation
    a. Control, communication and power circuits for each controller shall be individually electrically isolated to protect against transients, spikes, and power surges.
    b. The ports shall be optically and/or electrically isolated from each other, the controller circuit board and from power wiring.
    c. The controller shall be able to operate at 90% to 110% of nominal voltage rating.
    d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 3 feet.
6. Servicing:
    a. For ease of servicing, each controller shall consist of a removable plug-in circuit board.
    b. Products which require disconnection of wiring from the general application controller logic card before removal shall supply and install a quick disconnect type interconnection.
    c. If an air handler is located on the roof, locate equipment in conditioned enclosure of air handler.
7. Input/Output Modules:
    a. Analog inputs shall accept industry standard analog signals such as 4-20 mA, 0-5 VDC, and 0-10 VDC.
    b. Digital inputs shall accept binary contact closures.
    c. Digital outputs may be form C, latched or momentary contact type as required by the application.
        1) Digital output pairs controlling a tri-state motor/transducer or pulse width modulation shall not be utilized by general application controllers.
        2) Provide all digital outputs with hand/off/auto switches and LED status indication.
    d. Analog outputs shall have a 1% resolution over total output span of 0 to 100%.
        1) Provide all analog outputs with manual override switches and pot adjustments.
    e. Provide each control panel with a minimum 10% spare of each input and output type.

B. General Application Controller Software:
1. Provide complete controller software to execute all mechanical system local loop controls functions.

2. Controllers that require an EPROM burn to make permanent changes to the software configuration shall not be acceptable.
3. Each input, output, or calculation result shall be capable of being assigned to the network controller for system networking.
4. Each controller shall be fully programmable both from a portable service tool at the controller and through the network communication system from the front-end workstation. Programs shall be able to be changed online without effecting other programs or point monitoring.

2.5 FRONT-END SOFTWARE

A. BAS Seat License
1. Licenses shall be by concurrent user. Software shall be able to be installed on as many computers as necessary without additional licenses.
2. Each building shall provide a minimum of one seat license.
3. Additional licenses required are one seat license per 200,000 sq. ft. of lab or animal space and one seat license for every 400,000 sq. ft. of office and education space. No individual building shall be required to provide more than two seat licenses.

B. Software shall be a complete package including report management, alarm management, sequence programming language, live and historical data plotting capability, complete graphics with a library of HVAC symbols, program files for mechanical equipment and animation capabilities.

C. Software shall allow operator configurable reports that list in columns points chosen by the operator and attributes chosen by the operator.

D. Amount of trend data stored on the file server shall be limited only by the file server disk size and the discretion of the system administrator. Uploading data shall not effect the operation of the system.

E. Trend data shall be stored in an ASCI file for retrieval by standard “off-the-shelf” software programs.

2.6 WORKSTATION

A. Provide a minimum of one desktop workstation per building.
1. Newest version of Windows approved by the university ITS department
2. Processor speed, memory, should meet specifications necessary to run front-end BAS software without delays
3. Minimum RAM: one Gigibyte
4. CD reader/writer: DVD ROM/CD-RW
5. Ports: USB
6. Monitor: Minimum 17” flat panel LCD
7. Network: Provide an ethernet PC Card compatible with the campus BAS network.
8. Printer: Color Inkjet

B. The server-client workstations shall communicate via a campus-wide ethernet.

C. Perform all administrative tasks including but not limited to control program editing, graphics setup, alarm management, trend management, point setup, point commanding, report management and system setup.
1.

2.7 PORTABLE OPERATION WORKSTATION HARDWARE:

A. Provide one (1) portable operator workstation which shall run the workstation software and includes the following minimum hardware configuration:
1. Newest version of windows approved by the university ITS department

2. Processor speed, memory, should meet specifications necessary to run front-end BAS software without delays
3. CD reader/writer
4. Ports: Serial and USB
5. Monitor: Minimum 13" active matrix color LCD, Resolution sufficient to run BAS graphics without scrolling.
6. Power: Battery Life – 6 hours minimum. Provide Lithium-Ion type. Include (2) AC adaptors and (2) batteries.
7. Network: Provide an ethernet PC Card compatible with the campus BAS network.
8. Weight: 7.0 lbs. Maximum

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide a project manager who shall, as part of his duties, be responsible for the following
   1. Coordination between the Contractor and all other trades, the university, local authorities, and the design team.
   2. Scheduling of manpower, material delivery, equipment installation and checkout.
   3. Maintenance of construction records such as project scheduling and manpower planning and AutoCAD for project co-ordination and project record drawings.

B. Mount all panels at eye level in a workmanlike manor.

3.2 SYSTEM SETUP

A. Nomenclature: All point names shall comply with the existing point naming conventions. See Section 23 05 53 and the standard points list.

B. Point Setup
   1. See Section 23 09 32 for a list of required points.
   2. All physical analog outputs shall be setup to be commandable from the graphics with units of percent open to the energy source. This means mixed air dampers will be in percent open to outside air. The value of the physical units of the output shall also be available as live data.
   3. Points shall be setup so they read on reports and graphics with standard engineering units and without decimal places that exceed point updating or sensor accuracy.
   4. A graphic link will be installed for all points that are alarmed to allow drag and drop of alarms from the alarm status application to the appropriate graphic panel.

C. Trends
   1. All general application controller physical points, setpoints, and points on graphics shall be trended.
   2. All trends shall be scheduled for data transfer from the field panels to the database without data loss and without interfering with system operation.
   3. For archiving purposes, trends shall be setup to automatically transfer from the system database to files that can be easily used by standard spreadsheets.
   4. Analog points should have an interval trend of 15 minutes, 200 samples at the panel, and 45 days in the database.
      a. A change of value style of trend will be setup to record significant changes between the fifteen minute intervals.
   5. Digital points shall have change of value trends with a minimum of 50 changes from on to off or off to on stored in the panel, and 500 at the database or as needed for 45 days of data. Additionally, interval trend of 15 minutes, 200 samples at the panel, and 45 days at the database.

D. Locations

1. The room number for the mechanical system needs to be on the graphic. Where points on the graphic are not in the same room as the system, the location shall be in the point setup that can not be accidently deleted during manual manipulation of the point or on the graphic.

E. Graphics
1. The graphics should include all devices used by the control system and all controlled equipment.
2. The university must approve all graphic panels before they are copied.
3. All physical IO shall be on a graphic that enlightens the user to its function. All systems shall have graphics that convey accurate and complete schematic information about the equipment.
4. Graphics shall be clear and readable. Misleading details like construction room numbers and fonts that are too small to read shall not be used.
5. Use typical graphic developed by the university when available otherwise match existing style.
6. Each building will have a Building Chart that lists major AHU and building system parameters. It should be linked to each system graphic and the main graphic.
7. AHU graphics must contain utility and general information on the graphic. An air handler graphic shall have outside air and the properties of any chilled water, heating water, or steam supplied to the air handler.
8. The graphics shall either have links to all relevant graphics or be setup such that the operator will be able to navigate from the terminal box graphic to the relevant air handler graphic and back in less than three double clicks. The same shall be true between the terminal graphic and the related floor plan.
9. Each system graphic shall have a link to the sequence and a link to a maintenance log file.
10. Equipment references on the graphics will be compatible with the campus database naming conventions.
11. Controllers and miscellaneous alarm points will be located on the floor plan graphic.
12. Terminal equipment controller graphics shall be schematically correct, clear to read and have points arranged in a logical pattern to help viewer find information.
    a. All terminal box controllers, fan coils, unit heaters, exhaust boxes, etc. shall be located on a floor plan with a link to the relevant graphic.
    b. Terminal device graphics must contain utility and general information on the graphic. This would include supply air temperature, static pressure, heating water supply temperature or chilled water supply temperature as applicable.
    c. Terminal device graphics shall distinguish graphically between the type of equipment controlled such as VAV boxes, fan coils, hoods, general exhaust boxes etc...
    d. Points on the graphics that indicate position of terminal equipment controller outputs will read in percent open to energy source. All points necessary to command the outputs will be included on the graphics.
    e. Graphics shall be application specific with information on the discharge air temperature and pressure information specific to the air handler serving the terminal equipment controller.
13. Room numbers shall be included on the floor plans and shall be the university room numbers not the construction room numbers.
14. The operator shall be able to print any graphic including the live data.
15. Locate BAS panels on floor graphics.
16. Provide a graphic that overlays the mechanical contract drawing over the floor level graphics. Coordinate with BAS through the University Project Manager.
17. Show the miscellaneous points on the floor overview graphic at the installed location.
18. All points shall drag and drop and open the graphic associated with the point.
19. The graphics file shall be named the same as the background Designer file.

F. Alarms
1. Point alarms should follow the Standard Points List.
2. All general application controller and network controller communication failures shall be annunciated at the applicable system workstations as an alarm.
3. Priority 3 alarms shall be setup for failed batteries at the field panels.

4. All specified I/O device alarms shall be annunciated at the system workstation with alarm messages that clearly identify the type of alarm, the point in alarm and the value of the point in alarm.
5. All alarms shall be assigned priority levels with different notification strategies attached to each level. These alarm levels shall conform to the standards points list (see Section **23 09 32**). The system administrator shall have complete control over notification strategies and alarm levels.
6. Alarm priorities
    a. Priority 1: Life safety (oxygen alarms, fire alarm), alarm effects entire building operation or research, emergency showers, water detection, environmental chambers, and emergency chilled water system activation.
    b. Priority 2: Research area/building alarms
    c. Priority 3: Office and teaching/building area alarms
    d. Priority 4: General maintenance alarms, such filters that do not require an immediate response
    e. Priority 5: BAS alarms, error codes, field panel failure alarms, battery alarms, non building related alarms
    f. Priority 6: Customer equipment alarms
7. All alarms with high priority shall be annunciated on alphanumeric pagers.
    a. Pager messages shall be fully changeable by the system administrator. They shall clearly identify the type of alarm, the building, the point in alarm and the value of the point in alarm.
    b. Critical alarms shall be sent to the paging system within 10 seconds .
    c. All paging shall be enhanced to include a minimum time delay, unless it is a critical alarm.
8. The alarm logic shall include adjustable high and low alarm limits, mixed mode expressions, and equipment interlocks.
9. Unique high and low limits shall be supplied for each analog alarm point in the system.
10. The system shall be programmed to suppress alarm reporting on primary equipment that is in the inactive state.
11. All alarmed points where the location is not obvious must have the location of the point in the point informational text or graphics.
12. Nuisance alarm suppression
    a. Alarms shall have an adjustment delay for the alarm condition to clear before the alarm is sent to workstations or pagers. If the condition clears before the delay is over the alarm shall not be sent.
    b. When the alarm conditions clears there shall be an adjustable time delay before an alarm clear is sent. If the alarm condition clears before the delay is over then no alarm clear shall be sent and the point shall remain in alarm.
    c. Provide enhanced alarming for filters, temperatures, and pressures using enhanced alarming.
13. All alarmed points where the location is not obvious must have the location of the point in the point informational text or graphics.
14. Confirm paging of alarms with the university BAS staff.

G. Database:
1. After all punch list items have been completed export all of the following items and turnover to UCD:
    a. All points for every panel, including Virtual Points
    b. All terminal device points
    c. All programs
    d. All panel database files

H. Reporting:
1. Create the following reports:
    a. Trend Collection report
    b. Operator report
    c. Failed Point Report.

2. For archiving purposes, fifteen minute interval reports should be setup for each mechanical system. Once a month they should automatically export last month's data to a csv file on the file server. File names will be organized logically and include the date and system.

I. Graphing
1. Create the following graphs:
   a. Historical graph for the last 45 days of performance for each major mechanical system.
   b. Dynamic graph of performance for each major mechanical system.

3.3 COMMISSIONING

A. Engineer shall include a complete specification for testing all BAS components as part of Section 23 08 00. Final testing shall not begin until after system is connected to the campus system and accessible from existing workstations.

B. Project Record Documentation:
1. At least 3 working days before final acceptance demonstration, the contractor shall submit project record drawings of the BAS for approval by the university. If more than three errors or omissions are found during the university review or during the acceptance procedure the acceptance procedure will be cancelled and rescheduled when accurate and complete drawings are received.
2. Project Record Documents shall include all the information in the submittal drawings plus:
   a. All communication wiring shall have the exact route shown on a floor plan.
   b. Include the working construction drawings set from the installation sub-contractor.
   c. Exact locations of all devices including panels, communication devices, IO devices, etc. shall be shown. Construction room numbers if different from the university room numbers do not meet this requirement.
   d. All changes made during installation shall be shown.
   e. The electrical circuits used by the BAS should be clearly indicated as panel and circuit number.
   f. Unit communication address identifiers shall be shown.
   g. Conductor and pneumatic tubing identifier numbers.
3. After receiving final approval, supply six (or as specified on Division 1) complete project record drawing sets (maximum ANSI "D" size), together with an electronic copy to the university. The project is not considered complete until record documents have been received and certified complete and accurate by the university.
4. O&M manuals shall be provided that detail any maintenance required for any device in the system.
5. After all punch list, commissioning has been completed, and the before the university accepts the project
   a. Run reporting for any unresolved lines for all programming.
   b. Run reporting to find any unused points and delete them from the database.
   c. Run reporting to find any unused commissioning, trends, reports and unneeded graphics.
   d. Run reporting for any database errors in database using the system activity log.
   e. Run reporting a network performance diagnostic test and provide report to the university.

3.4 TRAINING

A. Contractor shall provide to the engineer and the university a training class outline prior to any schedule training.

B. The control contractor shall conduct on-site training courses for designated university personnel in the maintenance and operation of the control system.
1. A minimum of one class shall be given upon system acceptance. Classes shall be no longer than four hours in duration and budgeted at 1 hour of training time per 4000 sq. ft. of controlled area in labs and 1 hour per 7500 sq. ft. in office space. A minimum of one four hour class shall be provided.

2. Before training begins the O&Ms shall be complete the project BAS shall be communicating to the campus BAS.
3. Training sessions shall be provided for the university's personnel by factory trained personnel knowledgeable about all aspects of the installation.
4. Training outline shall be coordinated with University Engineering and shall include as a minimum.
    a. Instruction on specific systems and instructions for operating the installed system
    b. A tour of the installation to show the location of all system components
    c. A review of the project documentation.
    d. A review of the sequences of operation.
    e. A review of graphical commanding and alarming.
    f. A review of the troubleshooting procedures
    g. A review of terminal controller operations.
    h. A review of emergency operation due to utility loss (power, chilled water, steam), panel failures, and major mechanical or electrical systems.
    i. A review of the O&Ms and the working construction drawing set from the installation subcontractor.
5. Provide 8 hours total of seasonal loop tuning.

C. The BAS contractor will provide, at no cost to the university, standard training for the operations staff. Such training shall be adequate to fully enable the student to perform any required operating procedures in the BAS.

D. Forty hours of factory training shall be provided for any Lab building over 80,000 sq. ft. Eighty hours of factory training shall be provided for any lab building over 300, 000 sq. ft.

3.5 DEMOLITION

A. Demolition of an existing control system will include removal of controls which do not remain as part of the BAS, all associated abandoned wiring and conduit, and all associated pneumatic tubing.

B. The University Project Manager will inform the BAS Contractor of any equipment which is to be moved that will remain the property of the university. All other equipment which is removed will be disposed of by the BAS Contractor.

C. Existing controls which are to be reused must each be tested and calibrated for proper operation

D. Existing controls which are specified to be reused and are found to be defective requiring replacement will be noted to the University Project Manager. If necessary a change order will be issued to the contractor for repair or replacement of the defective device.

END OF SECTION 23 09 00

SECTION 23 09 13 - INSTRUMENTATION AND CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. The devices listed in this section are control system field devices generally connected to the Building Automation System. These devices have been placed in a separate section for clarity. See Section 23 09 00 for system standard and for items not clarified in this section.

B. Include all required factory and field calibration of each instrumentation device to accurately measure and control the desired variable.

C. Steam and chilled water connections and parameters from the Central Utilities Plant (CUP) to the individual buildings are further defined in Part 3 of the Manual of Guidelines and Standards for Design and Construction Projects and in the university Metering Standard.

D. All wiring requirements in this section shall be considered in addition to the requirements in Division 26 not in place of Division 26.

PART 2 - PRODUCTS

2.1 GENERAL

A. All input and output devices will be of the type which are universally accepted in the industry, can easily be second sourced and are fully compatible with the BAS.

B. Required components:
1. All components shall be included to meet the intent of sections 23 09 00 and 23 09 93
2. Pilot positioners shall be included where necessary to assure smooth operation of all analog pneumatic outputs.

2.2 SYSTEM INPUTS OR MEASUREMENT DEVICES

A. General
1. All sensor and signal conditioning equipment will be of the type which are universally accepted in the industry, can easily be second sourced and are compatible with all of the manufacturer's equipment.
2. See section 23 09 93 for required points.
3. Provide components that are fully compatible with the Building Automation System (BAS). Include all required factory and field calibration of each instrumentation device to accurately measure the desired variable.
4. All sensors to be installed in conditioned areas to prevent damage to the device. All devices to be installed in areas within the operating range of the device.

B. Temperature Transmitters:
1. General: Temperature sensor/transmitters shall have ranges appropriate for applications, input resolution of 0.2 Deg. F, accuracy of .4 degree F and stability of .3 degree F over the entire span. Pneumatic sensors are not allowed.
2. Space:
a. Space sensors (non-flush mounted) shall be provided with a portable service tool jack. Set-point adjustment will only be required as needed by LEED or the specific sequence of operation.

b. Sensors (non-flush mounted) shall be capable of providing temporary zone or building controls override, as needed by LEED and the specific sequence of operation.
c. Occupancy adjustment will only be required as needed by LEED or the specific sequence of operation.

3. Duct Averaging:
   a. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary.
   b. If the cross section of the duct where the sensor is located is larger that 24 inches long by 24 inches wide, averaging sensors of adequate length shall be specified to assure accurate temperature. Provide averaging sensors in all mixed air applications.
4. Outside Air: Sunshields shall be provided for outside air sensors.
5. Liquids
   a. Temperature sensors for liquids and steam shall have wells of appropriate type for the application and separable from the sensing element. Strap on sensors will not be accepted.

C. Differential Pressure Transmitters – Air and Water:
1. General: The differential pressure transmitters shall be temperature compensated.
2. Performance:
   a. Sensing range shall be suitable for the application with accuracy of +/- 1% including hysteresis and non-linearity of range and repeatability of +/- 0.2% of range.
   b. The sensor element shall be capable of withstanding up to 800% of rated pressure without damage.
   c. The sensor range shall be selected such that the anticipated set-point is approximately mid-range. Range may be larger if necessary to keep all anticipated measurements within the range.
3. Air Application:
   a. The sensor element shall be capable of withstanding at least 5 psi differential pressure.
   b. For applications referencing outdoor air, provide an outdoor static reference enclosure that eliminates wind effects.
   c. Provide a metal pitot tube for all duct static measurements.
   d. Provide a recessed housing with metal fittings designed for space static measurements.
   e. Provide bi-directional sensors for all air filter monitoring.
4. Water Application:
   a. For all water measurements, provide an isolation valve manifold and a permanently installed local visual gauge.
   b. The sensor element shall be capable of withstanding a pressure of twice the full scale pressure.
   c. Sensors shall have a minimum range of 0 - 50 PSI and a minimum of 100 PSI line pressure

D. Humidity Transmitters:
1. General:
   a. Humidity sensing elements shall be of the solid-state type.
2. Performance:
   a. The sensing element shall have a minimum range of 10% -99%, with an accuracy of +/_ 2% of range.
   b. Provide lockable metal guards for all sensors located in public areas.

E. Air Velocity Sensors For VAV Box Control:
1. General:
   a. The sensor shall sense a velocity range that is appropriate for each box.
   b. Repeatability including transmitter shall be +/- 5% of the CFM reading across the range of flow required by the application.
   c. The consultant shall determine if the airflow transmitter included in the controller will meet the above accuracy and specify an external transmitter where necessary.
2. Performance:

a. Thermal anemometer sensors shall use constant temperature differential technology and operate from 30F degree F to 120 F. degrees F
b. Differential pressure sensors shall provide periodic auto-calibrate to insure accurate velocity pressure measurement at low flows.

F. Refrigerant Gas Monitoring:
1. General:
a. Provide an alarm light, horn, local digital LED readout, and a 4-20mA analog output to the BAS.
2. Performance: Provide a halogen refrigerant gas monitoring system for the chiller room that shall specifically sense the type of refrigeration utilized in the chillers.
a. The sensing range shall be such that the alarm level is approximately mid range of the full sensing range, with accuracy of +/- 3% of full scale.
b. Sample each point a minimum of once every minute.
3. The alarm levels shall be as follows:
a. 10ppm for HCFC-123.
b. 100ppm for HFC-134A and R-22.

G. Flow Sensor – Air:
1. General:
a. The sensor shall utilize a multi-point airflow measuring array with a minimum of one sensing point for every two square feet of area (rounded down).
2. The accuracy of the flow measurement shall be +/- 3% of full scale.
3. Airflow measuring element accuracy shall be +/- 2% of the actual airflow span.
4. Differential Pressure Sensor/Transducer Performance: Refer to Differential Pressure Transmitter specification above.
5. Mount airflow probes on fan inlets with locknuts. When use of locknuts is not an option, the use of "lock-tight" is acceptable.
6. BAS air flow sensors shall be scaled to report in KCFM.

H. Flow Sensor – Steam / Energy Meter :
1. Vortex Type: Piping location for meter must meet the manufacturer's recommendation for minimum specified length of straight pipe. Meter sizing must consider maximum peak steam load and minimum steam flow during low load conditions (125 psi saturated steam). Dual station metering arrangement may be required to capture both peak flows and low-load off-season flow. Meter data communication must be coordinated with Building Automation System (BAS) interface requirements provided by Siemens. Acceptable communication protocols are Modbus and BACnet.
2. Meter must be in place and demonstrated to be operational to campus energy engineer prior to utility start-up.
a. Temperature and pressure compensated vortex-shedding mass flow meter.
b. Flanged, in-line body, flow element with electronic transmitter producing a linear flow signal.
c. High precision (0.4% of full scale) pressure transducer.
d. 20:1 turndown ratio or better, accuracy better than 1% of span.
e. Integrate meter data registers via approved communication protocol into Siemens BAS panel. Steam flow, pressure, temperature, flow totalizer registers are to be integrated into BAS at a minimum. Coordinate meter minimum and maximum flow output values with campus energy engineer through the University Project Manager.
f. Mass flow will be totalized by meter and be integrated into BAS.
g. NEMA 4X enclosure.
h. Alphanumeric LCD display with user selectable display options.
i. Integral mass flow totalizer with reset possible only with security code or non-resettable.
j. Remote display is required if meter cannot be reached without ladder. Display shall be installed at eye level while standing on floor.
k. Mounting hardware.

l. Calibration certification.

3. Acceptable Manufacturers: Sierra Instruments 240S or 240i series, Spirex/Sarco VLM series
4. Alternate technology acceptable product is Micrometer V-Cone series with KEP-ES flow computer for more difficult locations to meet manufacturer's installation requirements. This product will need UCD engineering services approval prior to use.

I. Flow Sensor –Chilled Water Meter :

1. Ultrasonic Type: Piping location for meter must meet the manufacturer's recommendation for minimum specified length of straight pipe The metering of the cooling energy (chilled water) is based on the total BTU (British Thermal Units) of energy delivered to the building converted to cooling Ton-hours. Determination of Ton-hours of energy requires a minimum of two temperature sensors (one on the supply line, one on the return line) and a flow meter, preferably on the supply line (building chilled water design conditions are CHWS=41 degree F and CHWR=56 degree F). Meter data communication must be coordinated with Building Automation System (BAS) interface requirements provided by Siemens. Acceptable communication protocols are Modbus and BACnet.
2. Meter must be in place and demonstrated to be operational to campus energy engineer prior to utility start-up.
   a. Dual channel transit time flow and energy meter. Utilize 2 meters for single channel meters.
      1) Channel 1 for primary chilled water.
      2) Channel 2 for secondary chilled water.
   b. High precision clamp-on flow transducers.
   c. Insertion (wetted) type RTDs w/ 4 wire output (balanced) individually accurate to within 0.1 degree F and provided as a matched pair.
   d. NEMA 4X enclosure.
   e. Alphanumeric LCD display with user selectable display options.
   f. Integrated energy (Ton-hour) totalizer with reset possible only with security code or non-resettable.
   g. Integrate meter data registers via approved communication protocol into Siemens BAS panel. Minimum required registers shall be water flow rate, supply and return temperatures, cooling tons, totalized ton-hours.
   h. Display shall be installed at eye level while standing on floor.
   i. Mounting hardware.
   j. RTD and flow transducer cables.
   k. Calibration certification.
   l. Acceptable Manufacturers: Siemens SITRANS FUE1010 series, Spirex/Sarco UTM10-E series, Sierra Instruments InnovaSonic 205i series

J. Carbon Dioxide Sensor:

1. General: The CO2 sensor shall utilize a single-beam, non-dispersive infrared detecting element.
2. Performance:
   a. The sensor shall have a range of 0-2000 ppm
   b. Accuracy +/- 50 ppm
   c. Repeatability +/- 10 ppm.
   d. Drift less than 20 ppm/yr
   e. Sensors shall be field calibrated for altitude.

K. Current Transducer:

1. General:
   a. Rated for 120% of maximum amperage of monitored system with 4-20 mA output.
   b. Provide matched removable clamp-on type current transformer.
2. Performance:
   a. Accuracy: +/- 0.5% of full scale
   b. Repeatability/Linearity: +/- 0.1% of full scale.

L. Level Transmitter:
1. Capacitance Type: PTFE coated 316 SS probe with ¾ inch NPT or 150 LB connection, 4-20mA output.
2. Displacement Type: C-Iron or steel case with 316 SS displacer, specific gravity adjustment, 4-20mA output.
3. Ultrasonic Type:
   a. Two-inch NPT connection, CPVC material, auto temperature compensation, NEMA-4X housing, 120 VAC power mA isolated output.
   b. Provide two adjustable relay contacts which may be set to alarm at particular level values, an electronic transmitter corresponding to 0-100% of level span, self-testing and calibrating and adjustable noise/echo filters.

M. Water meters:
1. Application: Domestic water, irrigation, evaporative cooling
2. Meters shall meet or exceed AWWA C700 and C710 Standards, utilize magnetic drive register, have excellent low flow measurement.
3. Water meters shall have a pulse output to the BAS.
4. Acceptable Manufacturers: Badger, Neptune, Sensus
5. Badger (preferred):
   a. Up to 2" Recordall disc series, over 2" Turbo series, all Badger meters require RTR pulse transmitter
6. Neptune:
   a. Up to 2" T-10, over 2" HP Turbine, all Neptune meters require TRICON/E3 pulse transmitter
7. Sensus:
   a. Up to 2" SR II, over 2" Turbo, all Sensus meters require Sensus Pulse transmitter

N. Electric Energy/Power Meter:
1. Reference Division 26.

2.3 SYSTEM OUTPUTS OR CONTROL DEVICES

A. Electro-Pneumatic Transducers (I/P):
1. General: Shall accept industry standard electronic signals and provide standardized pneumatic outputs.
2. Performance:
   a. The accuracy of conversion shall be 4% of full scale, linearity +/- 1% of full range at ambient temperatures of 40 to 120F.

B. Control Relays:
1. Shall be UL listed plug-in type with dust cover and LED "energized" indicator or RIB with indicator.
2. Contact rating, configuration and coil voltage shall be suitable for the application.

C. Manual Control Switches:
1. Shall be UL listed for use in NEMA 1 enclosures with contact arrangement and rating suitable for the application.
2. Bat handle or knob actuator with nameplate clearly identifying function of each switch position.

D. Low Temperature Protection Thermostats:
1. General:
   a. Shall be the manual reset type.
   b. The element shall be properly supported to cover the entire downstream side of the heating coil with a minimum of three loops.
   c. Separate thermostats shall be provided for each 25 square feet of coil face area or fraction thereof.

d. Provide a single point for low temperature reset button when 8 or more low temperature detectors are installed.

2. Performance:
   a. The set point shall be adjustable with a minimum range of 34 F to 50 F.
   b. The thermostat shall operate in response to the coldest one foot length of the 20 sensing element regardless of the temperature at other parts of the element.

E. Differential Pressure Switches:
1. Pressure differential switches (air or water service) shall be UL listed, Snap-acting, pilot duty rated (125 VA minimum), NEMA enclosure appropriate for the application, with scale range such that an adjustable set point is approximately at the mid-point of the device span.
2. Provide metal pitot tubes for airside differential pressure switches measuring duct static.

F. High/Low Static Pressure Limit Switches:
1. Shall be UL listed line voltage snap-acting pilot duty rated (125 VA minimum), NEMA 1 enclosure.
2. Provide manual reset unless otherwise required by the application
3. Provide metal pitot tubes for airside differential pressure switches measuring duct static.

G. Current Sensing Switches:
1. Shall be UL listed for line voltage with SPDT snap-acting, pilot duty rated (125 VA minimum) with range such that the set-point is at approximately the mid-point of span of the device.
2. Provide a maximum switching differential of 0.5 amps.

H. Valve or Damper Limit (End) Switches:
1. Shall be UL listed line voltage SPDT snap-acting pilot duty rated (125 VA minimum) NEMA 1 enclosure, with roller type actuating arm suitable for damper position application.
2. Provide end open and closed status switches as a minimum on all motorized valves utilized for equipment isolation. Provide end switches on all isolation dampers.

I. Positive Positioners:
1. General: Shall be high capacity force balance relay type with suitable mounting provisions and position feedback linkage tailored for particular actuator.
2. Performance:
   a. The positioner shall reposition the actuator on an input (pilot) signal change or 1/8 PSI or less.
   b. The repeatability shall be +/- 2%.

J. Electro-Pneumatic (EP) Solenoid Air Valves:
1. Shall be UL listed, snap-acting, 3 way air valve with 3-port (common, N.O, & N.C.).
2. Provide bronze or plastic body with stainless steel trim. Minimum safe pressure shall be 30 PSIG at 130 F ambient and/or control air temperature.
3. Provide coil voltages as required up to 460 VAC. Provide an open type for panel mounting or enclosed type with a NEMA 1 housing for remote installation.

K. Control Valves – Globe:
1. General: All control valves, unless otherwise required by application, shall meet the following:
   a. All modulating valve/actuator combinations for water application shall have linear flow or equal percentage characteristics in relationship to valve actuator input.
   b. The minimum close-off rating of any-two valve/actuator combination shall be 110% of the total system (pump) head for water application or 50 psid, whichever is greater.
   c. Valves shall have valve position indication on the valve.
   d. Water valves utilized in modulating applications shall be sized for a 4 to 6 psi drop with a maximum of 7 psi and a minimum of 3 psi. Application with flows less than 2 gpm may utilize pressure drops less than 3 psi.
   e. The valves shall be rated to 240 deg. F and 125 psig, two-way or three-way as required.

2. Valves ½" to 1":
   a. The valve body shall be nickel plated brass or bronze and provided with sweat or screwed fittings as required.
   b. Provide a screwed type with NPT fittings. Provide valves with equal percentage or linear flow characteristics.
3. Valves 1" to 6":
   a. The valve body shall be cast iron with a chrome nickel steel or stainless steel seat and inner valve material.
   b. Valves 1" to 2" shall be screwed type with NPT fittings.
   c. Valves 2-1/2" and larger shall be flanged.
   d. Provide linear flow characteristics.
4. Valves 6" and Greater: Provide one of the following types:
   a. Rotary globe valves equal to Masonelian Camflex II. Provide equal percentage or linear flow characteristics.
   b. Linear globe valves equal to Fisher. Provide equal percentage or linear flow characteristics.
   c. High performance butterfly valves/actuator combination that shall provide equal percentage flow characteristics at low flow. Provide Keystone K-Loc.

L. Control Valves – Butterfly:
1. General:
   a. Butterfly valves shall not be utilized for any modulating applications with valve sizes of six inches and under.
   b. Butterfly valves utilized for two-position control shall be line-sized.
   c. The minimum close-off rating for any two-way valve/actuator combination shall be 110% of the total system (pump) head for water application or 50 psid, whichever is greater.
   d. All valves shall have valve position indication on the valve.
2. Construction:
   a. Two-way and three-way butterfly valves shall have:
      1) a cast iron valve body
      2) aluminized bronze disc
      3) stainless steel stem
      4) disc seal suitable for bubble-tight shut off

M. Control Valves – Ball:
1. General:
   a. Ball valves shall not be utilized for modulating control unless approved by the engineer prior to bid. Exception: Only characterized ball valves providing equal percentage flow characteristics will be considered for modulating control applications.
   b. The minimum close-off rating for any two-way valves/actuator combination shall be 110% of the total system (pump) head for water applications or 50 psid, whichever is greater.
   c. All valves shall have position indication on the valve.
   d. The pressure drop calculations shall include the pressure drops of the fittings required to install a valves several sizes smaller than the pipe it is being installed in.
2. Ball Valves (2" or less):
   a. Valves shall utilize bronze bodies with female NPT threads. Valve bodies may also be stainless steel, titanium or nickel with operating pressure up to 2000 psi.
   b. Provide a blowout proof stem design, glass-reinforced Teflon thrust seal washer and stuffing box ring with minimum 600 psi rating. Stem packing gland screw shall be adjustable for wear.
   c. Standard chromium plated bronze ball or where specified, stainless steel ball and stem, shall be rated at a minimum of 600 psi water, cold, non-shock service, and 150 psi for saturated steam service. All valves shall be provided with reinforced Teflon seats.
3. Ball Valves (2-1/2" to 6"):
   a. Valves shall have flanged carbon steel or stainless steel bodies rated at 150 psi working pressure.
   b. Provide a blowout stem design and reinforced PTFE thrust seal washer.

c. Provide a stainless steel ball and stem and reinforced PTFE seats, packing and o-ring.

N. Control Valves – Low Pressure Steam:
1. General:
   a. Low pressure steam valves shall be sized for a maximum 42% pressure drop of inlet pressure.
   b. The minimum close-off rating any two-way valve/actuator combination shall be inlet pressure for steam applications.
   c. All valves shall have valve position indication on the valve.
   d. All modulating valve/actuator combination for steam applications shall have equal percentage flow characteristic in relation to valve actuator signal input.
2. Construction:
   a. The valves shall be two-way with a rating to 360 deg. F up to 230 psig.
   b. The valve body shall be cast iron with a chrome nickel steel or stainless steel seat and inner valve material.

O. Control Valves – Chilled water Infrastructure Connection
1. General:
   a. The control valve must be a two-way valve design.
   b. The control valve must be of industrial quality.
   c. When combined with actuator, the assembly must deliver a minimum 100:1 turn-down ratio.
   d. The minimum close-off rating any two-way valve/actuator combination shall be inlet pressure of 100 psi (230’ W.C.) differential.
   e. All valves shall be sized for 3-5 PSID pressure drop across the valve at full flow.
   f. All valves shall have valve position indication on the valve.
   g. All modulating valve/actuator combination for this application shall have equal percentage flow characteristic in relation to valve actuator signal input.
2. Construction:
   a. The valves shall be two-way with a rating to 360 deg. F up to 230 psig.
   b. The valve body shall be cast iron with a chrome nickel steel or stainless steel seat and inner valve material.
3. Acceptable Manufacturers: Keystone, Fisher, or approved equivalent.

P. Valve Actuators – Chilled water Infrastructure Connection
1. General:
   a. Shall provide tight close-off at design system pressure and shall provide smooth modulation at design flow and pressure conditions.
   b. The control valve actuator must be of industrial quality.
   c. When combined with actuator, the assembly must deliver a minimum 100:1 turn-down ratio.
   d. The minimum close-off rating any two-way valve/actuator combination shall be inlet pressure of 100 psi (230’ W.C.) differential.
   e. The valve actuators shall be electrically actuated with proportional modulation and must fail in place.
   f. All modulating valve/actuator combination shall have valve position indication on the actuator.
   g. All modulating valve/actuator combination for this application shall have equal percentage flow characteristic in relation to valve actuator signal input.
   h. Provide a hand wheel or manual position dial to allow manual positioning of valve.
   i. Provide actuators with internal heaters if installed outdoors.
   j. Provide end (limit) switches for open/closed position indication feedback.
   k. Provide a position indicator feedback signal. Signal shall supply a mA or VDC analog feedback signal. It shall have infinite resolution with a linearity error of less than +/- 1% of full span.

l. Upon loss of analog control signal, the actuator shall have the ability of to stay in place, drive fully open, drive fully closed or drive to a pre-determined position.

2. Construction:
   a. The actuator shall function normally at temperatures of 40 to 185 degrees F, 0-99 % humidity, and withstand short temperature excursions 10% above the rated temperature with no permanent damage to the unit.
   b. The motor shall be a no burnout type, with no duty cycle limitations, capable of 60 starts and stops per minute for high-demand times such as start-up and process upsets.
   c. The actuator shall hold a minimum of 200% of the rated torque when the motor is de-energized
3. Acceptable Manufacturers: Beck, or approved equivalent.

Q. Control Dampers:
1. Motorized dampers, unless otherwise required by the application, shall meet the following:
   a. Damper frames shall use 12 or 13 gauge galvanized steel channel or 1/8" extruded aluminum with reinforced corner bracing.
   b. The damper blades shall not exceed eight (6) inches in width or 48" in length.
   c. Damper bearings shall be oil-impregnated sintered bronze or bearing grade nylon. Bushings that turn in the bearing are to be oil impregnated sintered metal.
   d. All blade edges and top and bottom of the frame shall be provided with replaceable, butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel, synthetic elastomer, or combinations of both. The seals shall provide a maximum leakage rate of ½% of maximum flow or 10 CFM/SF leakage at 4" W.C. close-off pressure.
   e. The damper linkage shall be concealed and provide a linear flow or equal percentage characteristic as required.
   f. Airfoil type dampers shall be used for any modulating air volume applications, pressure control applications, or air velocities greater than 1500 FPM.
   g. Provide a minimum of one damper actuator per damper section.
2. Blade Arrangement:
   a. Unless parallel blade dampers are necessary for mixing outdoor/return air streams, dampers other than fire dampers shall be opposed blade type.

R. Electronic Actuators:
1. Value Actuators for Primary HVAC Equipment:
   a. Shall provide tight close-off at design system pressure and shall provide smooth modulation at design flow and pressure conditions.
   b. The valve actuators shall be electrically actuated with proportional modulation and spring return.
   c. Provide a hand wheel at the valve or manual position dial mounted in the BAS panel to allow manual positioning of valve.
2. Valve Actuators for Butterfly Valves:
   a. Shall provide tight close-off at design system pressure and shall provide smooth modulation over the full range of expected flow and pressure conditions.
   b. Provide actuators with internal heaters if installed outdoors.
   c. Provide 2 sets of end switches, one set for limiting of the stroke, the other set for open/closed position indication feedback.
   d. Provide a hand wheel at the valve or manual position dial mounted in the BAS panel to allow manual positioning of valve.
3. Valve Actuators for VAV Terminal Units:
   a. The valve actuator shall be electrically actuated with proportional or 3 point floating modulation.
   b. Thermally actuated valve actuators are not acceptable.
4. Damper Actuators for Primary Equipment:
   a. Shall be selected per manufacturer's recommendations to provide sufficient close-off force to effectively seal damper and to provide smooth modulating control over the full range of expected flow and pressure conditions.

b. Shall be proportional modulating or 2-position as required by the application and have a position indicator for external indication of damper position.
c. Provide modulating actuators with manual override release to manually position the actuator without disconnecting damper linkage.
d. Provide adjustable stops for both open and closed positions.
e. Provide spring return to the closed position on all dampers that open to the outdoors.

5. Damper Actuators for VAV Box Terminal Unit Control:
a. Provide a rotary type capable of permanent stall operation without damage.
b. Provide adjustable stop pins on the actuator for stroke limit.
c. The actuator shall fit directly over the damper shaft.
d. VAV terminals 3,000 CFM or greater must be provided with high torque actuator.

S. Pneumatic Actuators:
1. General:
a. Pneumatic actuators shall be piston-rolling diaphragm type with easily replaceable beaded, molded neoprene diaphragm.
b. Actuator size and spring ranges selected shall be suitable for intended application.
c. Provide a manual position dial mounted in the BAS panel to allow manual positioning of each actuator or group of actuators utilized for a modulating control application.
d. All modulating valve applications shall be provided with spring return to the normal position.
e. All damper applications with outdoor air openings shall be provided with spring return to the closed position.
f. All actuator torque rating shall be 150% of the requirements of the application.
2. Damper Actuators:
a. Shall be selected per manufacturer's recommendations to provide sufficient close-off force to effectively seal damper and to provide smooth modulating control under design flow and pressure conditions.
b. The actuator body shall be cast aluminum.
3. Valve Actuator:
a. Shall provide tight close-off at design system pressure and shall provide smooth modulation over the full range of expected flow and pressure conditions.
b. The actuator body shall be cast aluminum.
4. Positive Positioners: Shall be provided on actuators for inlet vane control, modulating dampers, and modulating valves to provide smooth modulation or proper sequencing.

2.4 AUXILIARY EQUIPMENT

A. Building Automation System (BAS) Controls Transformers:
1. Shall be UL listed Class 2 current limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

B. Pneumatic Indicating Gauges and Test Ports:
1. Control signal indicating and test gauges shall be 1-1/2", back-connected, 0 to 30 PSIG.
2. Test ports shall be quick-disconnect type using needle probe or threaded pin valve type.
3. Permanent indicating gauges shall be furnished for all pneumatic transducer and relay outputs used to position actuators or PE switches.
4. Gauges shall be in local control panels when applicable.
5. Test ports shall be provided for all EP, relay and signal conditioning inputs which do not directly signal actuators.
6. One main (supply) air pressure gage shall be installed in each local control panel.

C. Enclosures:
1. General:
a. Mounting: All Controllers, Relays, Transducers, transmitters, relays, etc. shall be housed in a NEMA enclosure rated for the installed conditions.

b. Panels shall be NEMA type suitable for applications as required with hinged door and key-lock latch.

2. Terminations and Connections:
   a. Interconnections between internal and face-mounted devices pre-piped and wired with color-coded tubing/conductors shall be neatly installed in plastic tray and/or tie-wrapped.
   b. All wiring within the panel shall be shall be run in wiring tray in accordance with NEMA and UL standards, and shall meet all local codes.
   c. Terminals for field connections shall be UL listed for 600V service, individually identified per control shop drawings, with adequate clearance for field wiring.
   d. Control air terminations for field connection shall be individually identified as per control shop drawings.
3. General Application Controller Panel Enclosures
   a. Provide a 120 VAC receptacle in each panel, and a fused on /off power switch for the panel power supply. Where ganged together panels within 8 feet of each other may be served by the same convenience 120 VAC receptacles.
   b. Provide a main air gauge for control power sources to each local panel containing pneumatic controls. Provide air gages for each pneumatic output. Indicator lights on BAS outputs similar to Siemens module PTM6.1 do not meet this standard.
   c. Provide a final as-built control drawing of panel and related devices, reduced, laminated, and mounted inside of the panel door.
   d. Use of existing control panels to house new controllers is discouraged. Use of existing control panels for junction panels is acceptable under the following conditions.
      1) All excess devices, wiring and tubing shall be removed.
      2) All remaining devices, wiring and tubing shall be tagged and neatly revised.

D. Wiring and Conduit:
1. All wire will be copper and meet the minimum wire size for the application.
2. Input wiring shall not be in the same conduit as power wiring. Communication wiring shall not be in the same conduit as power or output wiring.
3. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
4. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum ½ inch galvanized EMT. Compression fittings shall be used for interior locations and watertight compression fittings for exterior locations. Provide conduit seal off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
5. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuator controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
6. Junction boxes shall be provided at all cable splices, equipment terminations, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with cover. Exterior and damp location J-boxes shall be cast alloy FS boxes with threaded hubs and gasket sealed covers.
7. Wire inside walls should be in conduit, low voltage wire in ceilings should be ran in the information system cable tray and should enter room along with other low voltage wiring through a 2” conduit from the cable tray to a point of penetration in the adjacent room and run on J Hooks or bridle rings in the ceiling space of a room.
8. Low Voltage/Wire and Cable: All LV/W&C shall be run in conduit in floors and walls spaces. In hallways LV/W&C shall be run in the common telecom and other low voltage system cable tray. LV/W&C must be run in a conduit sleeve, minimum 2” dia. with plastic bushings, from the point it leaves the cable tray to the interior side of a room. Once the LV/W&C enters the room it can be supported from bridle rings or j-hooks. Wiring shall comply with Section 28 31 00 and approved NEC.
9. Low Voltage/Wire and Cable and Hallway Devices: LV/W&C running from the cable tray to devices in the hallway shall be protected by plenum rated flexible sleeving or flexible metal conduit. LV/W&C in sleeving or flexible metal conduit shall be supported per NEC and installed with UL approved connectors and plastic bushings on both ends.

10. Low Voltage/Wire and Cable Insulation Sleeve Color: BAS conductor insulation colors allowed are:
    a. Points Blue Jacket
    b. BLN Orange Jacket
    c. FLN Orange with blue stripe jacket
    d. Power Dark blue or black jacket
11. Where the space above a suspended ceiling is a supply or return air plenum, any wiring not run in conduit shall be plenum rated. EXCEPTION: Any wire run in suspended ceiling that is used to control outside air dampers, provide smoke control functions or to connect the system to the fire management system shall be in conduit.

E. Pneumatic Tubing:
1. Provide a complete air piping system for pneumatic actuator controls.
2. Control air piping shall be hard drawn type "L" copper tubing with wrought copper fittings and lead free joints.
3. Polyethylene tubing "FR" (flame retardant and self-extinguishing) can only be for terminal connections to devices with a maximum length of 18 inches and within control cabinets, enclosed raceways or conduits.
4. All pneumatic tubing shall be copper tubing or routed within a metallic conduit system
5. Conceal piping except in:
    a. Mechanical rooms.
    b. Areas where other piping is exposed.
6. Secure exposed copper tubing at regular intervals and run parallel with the lines of the building.
7. Install only tool-made pipe bends.
8. Where exposed in mechanical rooms and occupied spaces, support non-metallic tubing in:
    a. Adequately-supported, rigid, metallic raceways (conduit).
    b. EMT pipe
    c. Install in a neat and workman-like manner.
9. Fasten flexible connections bridging cabinets and doors, neatly along hinge side. Protect against abrasion
10. All tubing penetrating a metal barrier (i.e. air handler casing or duct) shall be protected with bulkhead fittings
11. Tie and support the tubing neatly.
12. Number-code or color-code tubing, except local individual room control tubing for future identification and servicing of control system,
13. Do not install pneumatic devices or tubing where there is danger of freezing.
14. Provide gauges on all branch lines from transducers. Locate in cabinet.
15. Provide gauges on all output transducers.

PART 3 - .EXECUTION

3.1 INSTALLATION, GENERAL

A. Remote control devices not in local panels shall be accessible for adjustment and service-below 7' above finished floor whenever possible.

B. All transducers, transmitters, relays, etc., shall be mounted in a panel with hinged doors in an orderly manner and shall be properly labeled with permanent labels to identify the parts of the system being served. All thermostats shall be labeled with device number and point address.

C. Component panels shall be mounted at eye level for accessibility and service, and located within 50 feet of the system served, unless otherwise shown on the plans.

3.2 SYSTEM INPUTS OR MEASUREMENT DEVICES

A. Temperature Sensors:
   1. Space: Mount room temperature sensors 60 inches above finished floor.
   2. Outside Air:
      a. The contractor is responsible for providing a sensor that accurately reflects outdoor air temperature throughout the year in any weather conditions.
      b. The outside air temperature sensor shall be located on a northern exposure away from any heat sinks or sources.
      c. Sunshields shall be provided such that the sensor is shaded for all possible solar angles.
   3. Duct Averaging
      a. The sensor shall be installed according to manufacturer's recommendation and looped and fastened at a minimum of every 36 inches. Firmly supported ½' EMT is acceptable.
      b. The sensor shall be thermally isolated from the unit.
   4. Water:
      a. Temperature sensors for liquids and steam shall be installed in wells of appropriate type for the application. Strap on sensors will not be accepted.
      b. Coordinate the locations of all thermo wells to provide for accurate and reliable temperature readings.
      c. Provide heat conductive compound between the well and sensor element.

B. Low Temperature Protection Thermostats:
      a. All low limit thermostats shall be firmly supported in the ductwork or air handling unit using ½" EMT or other auxiliary support.

C. Humidity Transmitters: Duct mounted sensors shall be mounted a minimum of 20 duct diameters downstream of any type of humidifiers or evaporative cooling equipment.

D. Differential Pressure Transmitters:
   1. Coordinate the locations of all water pressure differential transmitters such that the transmitter is located in the hydronically furthest lines. Confirm that there are no automatic modulating or two position valves between the transmitter taps and the pump.
   2. Locate the air pressure differential transmitter for VAV fan control approximately 2/3rd of the distance down the furthest duct. A location at or near the air handling system supply fan discharge is unacceptable.

E. Flow Meters
   1. All weld-o-lets for flow meters must be installed in a manner that no lip is in the pipe.

F. Airflow Stations
   1. The installation shall be a minimum of 10 duct diameters below and 5 duct diameters above any tees or elbows in the ductwork or in the inlet cone for each supply and return fan. If the fans are double wheel double inlet (DWDI) fans, provide a flow sensor at each fan inlet.

G. Air Velocity Sensors for Terminal Box Control
   1. The terminal box air flow measurement needs to be installed with the minimum duct diameters to assure accurate measurement of minimum ventilation air flow.

H. Differential pressure Switches
   1. All differential pressure switches shall be calibrated to specifications provided by the mechanical engineer.

3.3 AUXILIARY EQUIPMENT

A. Wiring Installation Methods:
   1. General:

a. At a minimum, install systems and materials in accordance with manufacturer's instructions, rough in drawings and equipment details.
b. Install electrical components in compliance with requirements of applicable Sections of Division 26.
c. Install all control wiring 50 volts and above in conduit.

2. Installation:
a. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines, with adequate support and shall be supported from or anchored to structural members.
b. Conduit supported from or anchored to piping, duct supports, the ceiling suspension system, or other electrical conduits are not acceptable.
c. Wiring buried in slab on grade concrete or explosion proof areas shall be in rigid metal conduit.
d. Provide adequate strain relief for all field terminations.
e. Varistors shall be installed on the control side of all output relays and on both sides of the transformers.
f. All terminations shall be neat with no stray strands.
g. An additional number of spare wires shall be included in each run as determined by the university for future use.

B. Control Air Piping Installation Methods:
1. General:
a. All control air piping shall be installed in a neat and workmanlike manner parallel to building lines with adequate support.

2. Installation:
a. Piping above suspended ceilings shall be supported from or anchored to structural members.
b. Tubing shall not be supported by or anchored to electrical conduits or the ceiling suspension system.
c. Sleeve through concrete surfaces in minimum one inch (25 mm) sleeves, extended 6 inches (150 mm) above floors and one inch (25 mm) below bottom surface of slabs.
d. Isolate air supply with wire-braid reinforced rubber hose or polyethylene tubing.
e. Purge tubing with dry, oil-free compressed air before connecting control instruments.
f. Lines buried in slab on grade concrete shall be in rigid metal conduit. Lines in concrete or masonry walls shall be in EMT.
g. All pneumatic piping that penetrates metal shall be protected with grommets from wear from the metal.

C. Identification:
1. General
a. Verify label nomenclature with the university before engraving or printing.
b. All control equipment shall be individually and clearly identified by control shop drawing designation:
c. Paper labels are not acceptable.

2. Control Panels
a. Provide engraved Bakelite or lithographed metal nameplates with panel number and system served
b. Utilize white ½ inch high letters on a black background.
c. Embossed labels are not acceptable

3. Component sub-panels – metal tags or laser printed, adhesive backed, metallized polyester film labels.
4. Control valves and damper actuators – brass tags or engraved Bakelite tags.
5. Other remote control devices – metal tags or laser printed, adhesive backed, metallized polyester film labels.
6. Control Conduit Junction Boxes – Painted with a Blue/Green stripe.

7. Label room temperature sensors with point name and address of the terminal controller served by the sensor.
8. For all control devices located above the ceiling attach an additional label to the ceiling “T” frame with pop rivets. Use engraved nameplates, 3”x1”, black lettering on white background.
9. Number-code conductors and pneumatic tubing appropriately for future identification and servicing of control system. Reflect this tagging or color coding system on the Project Record Documents

D. VFD interface wiring.
1. All safety circuit and BAS control wiring to VFDs shall be connected to a terminal strip in a NEMA enclosure external to the drive before entering the drive. This is to allow servicing these circuits without opening the drive.

END OF SECTION 23 09 13

SECTION 23 20 00 - PIPING

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Snow Melt
1. The use of snow melt systems is discouraged because of high energy use.
2. Snow melting installations are divided into two classes.
   a. Class I: Main pedestrian entrances, walks or driveways on the north side of the buildings.
   b. Class II: Commercial sidewalks and driveways.
3. Design snow melt systems for areas critical to safety. It is unacceptable to have snow on the snow melt surface for any length of time. Consider snow melt systems for sidewalks, loading docks, service entrances, main entrances and steps.
4. Base typical system for 150 Btu-h per square foot with a 10-mph wind at 0 degrees F.
5. Provide systems with 60 percent water and 40 percent Dowfrost.
6. Provide dedicated steam to water heat exchanger(s).

B. Pipe Connections: Provide required straight sections for flow measurement stations.

C. Expansion Compensation:
1. Piping and joints shall be designed to eliminate damage by expansion and contraction.
2. Mechanical expansion devices are discouraged. Expansion loops are preferred. Where mechanical expansion devices are necessary, bellows type shall be specified. Other types with mechanical seals are not permitted.
3. Devices shall be readily accessible for maintenance and repair per the manufacture’s recommendations.

D. Natural Gas Piping Systems:
1. Provide shut-off cocks on all branch lines, and lab benches, and make cocks easily accessible for service and operation. Provide drip legs at all equipment connections. Use pipe dope on threaded pipe fittings, Teflon tape is prohibited.

E. Sanitary Sewer Piping Systems:
1. Provide manholes at major junctions of exterior sewer lines, and provide cleanouts on all other junctions.
2. Locate interior clean-out caps and plugs such that they can be removed without damaging the surfaces in which they are installed.
3. Do not discharge chemical waste, oils, antifreeze, and other wastes into the sanitary sewer without written approval of the University Project Manager. Coordinate the requirement of acid neutralizing systems and sand and oil interceptors with the University Project Manager.
4. Do not discharge domestic water used for cooling into the sanitary sewer except for emergency back up for critical systems and vacuum systems.

F. Storm Drain Piping Systems:
1. Do not discharge sanitary waste into the storm sewer system. Do not discharge storm drain water into the sanitary waste system.

G. Ejector Pumps
1. At system low points where gravity drain is not possible provide duplex sump pump systems with high water alarms connected to Building Automation System. Provide gravity drainage piping downstream of pumps sized to accommodate the discharge of both pumps running at the same time and any additional load produced from normal gravity drainage.

2. Provide sump pump controls with a manual selectable, alternating relay to switch lead-lag operation.
3. Provide all sump pumps with standby or emergency power.
4. Stainless Rails, chains, etc Removable System…
5. Provide flanged pump connections.

H. Chemical and Acid Waste Systems:
1. Discuss the treatment and handling of chemical and acid wastes with the University Project Manager. Typically, most wastes at the university are collected in containers and are disposed of through the university and the need for acid waste pipe is the exception. Acid wastes may be generated in deionized water systems and in these cases a neutralization system must be approved by the University Project Manager through EH&S and Operations.
2. Where chemical and acid waste is required by specific circumstance and it is virtually inaccessible (i.e., concrete slab) polypropylene pipe should be used in these locations.
3. Lab waste lines shall be constructed from polypropylene pipe with mechanical joints.
4. Building waste water effluent must meet state and federal regulations.
5. Pretreatment may be necessary based on specific program requirements.
6. Engineer to determine whether pretreatment is recommend based on discussions with program representatives regarding types and amounts of chemicals and other materials with which they will be working
7. Provide sampling ports building discharge for laboratory effluent systems.
8. Coordinate with regulatory agencies, including Metro Waste Water.
9. Coordinate requirements closely with the University Project Manager.

I. Potable Water Piping System:
1. Lead pipe or lead solder is prohibited for all potable water piping systems.
2. Make domestic water piping joints with lead free solder.
3. Size domestic water piping to maintain maximum velocities of 8 feet per second for cold water and 5 feet per second on hot water and hot water circulation piping.
4. Provide main shutoff valve for potable water inside the building.
5. As a minimum, provide shut-off valves at each branch, floor, equipment and bathroom group.

1.2 QUALITY ASSURANCE

A. Welders Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications

B. Welding procedures and testing shall comply with the latest revisions of the applicable sections for B31, of the ANSI/ASME standard codes for pressure piping, noted as “B31.9 Building Services Piping”.

C. The types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of the ASME Code for Pressure Piping, ANSI/ASME B31.1 - Power Piping. If requirements for non-destructive examination are to be other than that stated above, the degree of examination, and basis for rejection shall be a matter of prior written agreement between the fabricator, of contractor and the purchaser.

D. Soldering and brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

E. Welding: All welding work shall be performed by welders certified to ASME or AWS standards within the last year for the type of material and application suited for the job. Contractors shall submit copies of qualification tests of the welders to the Project Manager prior to construction.

F. ASME B31.9 “Building Services Piping” for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

1.3 WARRANTY:

A. Manufacturer’s warranty of 25 years for snowmelt tube and 18months for snowmelt manifolds.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years
2. Grooved Piping:
   a. ITT Grinnell Corp.
   b. Victaulic Co. of America
3. Piping Connectors
   a. Fernco, Inc.
4. Pipe Thread Sealant
   a. The Rectorseal Corp.
5. Drainage Piping Specialties, including backwater valves, expansion joints, drains, cleanouts, flashing flange and vent flashing sleeve.
   a. JR Smith
   b. Zurn Industries
   c. Wade
   d. Josam
6. Gas Cocks
   a. Crane
   b. Hammond
   c. Peter Healy

B. Acceptable Manufacturers - Snowmelt: Subject to compliance with requirements, provide products by the following:
1. Tube, Fittings, Pipe, and Manifolds:
   a. Uponor
   b. Watts Radiant
   c. Quest Hydronics
2. Controls: Integrated into BAS (preferred)

2.2 MATERIALS, GENERAL - SNOWMELT

A. Provide components of the buried tubing system by one manufacturer, including tubing, fittings, manifolds, and ancillary items.

B. Small Systems, Less Than 5000 Square Feet:
1. Tube: ASTM F876, cross linked polyethylene, 5/8-inch inside diameter, rated at 180 degree F maximum working temperature and 100 psi working pressure, with oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than 0.10 g/m3/day at 104 degree F. Minimum bend radius for cold bending shall no be less than six times the outside diameter.
2. Fittings: Dezincification resistant brass fittings consisting of a barbed insert, compression ring, and compression nut.

3. Manifolds: Cast brass construction, manufactured of alloys to prevent dezincification, with integral circuit balancing valves. Provide with support brackets and tube bend supports. Isolate manifolds from supply and return tubing with valves suitable for isolation and balancing. Manifolds shall be capable of venting air from the system.

C. Large Systems, Over 5000 Square Feet:
1. Tube: ASTM fd3350, cross linked, low density polyethylene without oxygen diffusion barrier. 7/8-inch inside diameter, rated at 140 degree F maximum working temperature and 55 psi working pressure.
2. Fittings: Dezincification resistant brass fittings or HDPE,SDR 11 polyethylene fittings.
3. Manifolds: Pre-manufactured of HDPE, fusion welded, designed for balanced flow. Include proper fittings or compression clamping sleeve and locking caps.

D. Supply and Return Main Pipe:
1. 2 Inch and below: ASTM F876, cross linked polyethylene, rated at 180 degree F maximum working temperature and 100 psi working pressure with oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than 0.10 g/m3/day at 104 degree F.
   a. Fittings: Brass or Bronze
2. Above 2 Inches: Industrial pressure pipe, HDPE polyethylene pipe, fusion welded.
   a. Fittings: HDPE, SDR 11, fusion welded.

E. Access Covers:
1. Removable access covers constructed of reinforced concrete formed in place or precast concrete over pipe connections, fittings, and distribution manifolds. Provide tapered forms for covers. Covers subject to vehicular traffic shall be traffic rated.

F. Controls:
1. Control by Division 23 09 00..

2.3 MATERIALS, GENERAL

A. Piping Materials: Provide pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class in not indicated, provide proper selections determined by Installer for installation requirements, and comply with governing regulations and industry standards.

B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, and valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

C. Steel Pipes and Pipe Fittings:
1. Black Steel Pipe: ASTM A53, Grade B, Type E, electric resistance welded.
2. Galvanized Steel Pipe: ASTM A 53, Grade B.
3. Seamless Steel Pipe: ASTM A53, Grade B, type S or A106 high temperature.
4. Stainless Steel Pipe: ASTM A312; Grade TP 304 (high temperature and corrosive service, 1/8-inch through 30-inch.
5. Coal Tar Protective Coatings and Linings for Ductile Iron Water Pipe: AWWA C203 for enamel and tape, hot applied.
6. Cement-Mortar Protective Lining and Coating for Steel Pipe: AWWA.
7. Steel Water Pipe: AWWA for pipe 6-inch and larger.
8. Cast-Iron Flanged Fittings: ANSI B16.1, including bolting (class 125 and 250)
9. Cast-Iron Threaded Fittings: ANSI B16.4; plain or galvanized as indicated (Class 125 and 250)
10. Malleable-Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated (Class 125 and 300)

11. Malleable-Iron Threaded Unions: ANSI B16.30, Class 150, 250 or 300; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated (Class 150, 250 and 300).
12. Threaded Pipe Plugs: ANSI B16.14.
13. Steel Flanges/Fittings: ANSI B16.5, ASTM A234 (Fire Protection) including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
14. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing (threaded where pressure is not critical).
15. Forged-steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe up to 4 inch pipe size).
16. Wrought-Steel Butt-welded Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.
17. Cast-Iron Threaded Drainage Fittings: ANSI B16.12.
18. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.
19. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less that Schedule 80 pipe where length remaining unthreaded is less that 1-1/2 inch and where pipe size is less than 1-1/2 inch, and do not thread nipples full length (no close nipples).

D. Copper Tube and Fittings:
1. Copper Tube: ASTM B 88; Type K or L as indicated for each service; hard-drawn, except as otherwise indicated.
2. DWV Copper Tube: ASTM B306
3. ACR Copper Tube: ASTM B280.
4. Cast-Copper Solder-Joint Fittings: ANSI B16.18.
5. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.
6. Cast-Copper Solder-Join Drainage Fittings: ANSI B16.23 (drainage and vent with DWV or tube).
7. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.
8. Cast-Copper Flared Tube Fittings: ANSI B16.26
9. Bronze Pipe Flanges/Fittings: ANSI B16.24 (Class 150 and 300)
10. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

E. Brass Pipe and Fittings:
1. Red Brass Pipe: ASTM B43 (boiler feed pipe, 1/8 inch through 12 inch, regular or extra strong weight)
2. Cast-Bronze Threaded Fittings: ANSI B16.15, Class 125 or 250.
3. Cast-Bronze Threadless Fittings: ASTM B61 or B62 brazed joints.

F. Cast-Iron Soil Pipes and Pipe Fittings:
1. Hubless Cast-Iron Soil Pipe: FS WW-P-401 and CISPI Standards 301 and 310.
2. Cast-Iron Hub-and-Spigot Soil Pipe Fittings: Match soil pipe units; complying with ASTM A74.
3. Hubless Cast-iron Soil Pipe Fittings: Neoprene gasket complying with ASTM C564, CISPI Standard 310 and stainless steel clamp holding band.
4. Cast-Iron Hub-and-Spigot Soil Pipe Fittings: Match soil pipe units; complying with ASTM A74.
5. Neoprene Compression Gaskets: ASTM C564

G. Grooved Piping:
1. Coupling Housings: Malleable iron conforming to ASTM A47.
2. Coupling Housings: Ductile iron conforming to ASTM A536.
3. Coupling Housings Description: Grooved mechanical type, which engages grooved or shouldered pipe ends, encasing an elastomeric gasket which bridges pipe ends to create seal. Cast in two or more parts, secure together during assembly with nuts and bolts. Permit degree or contraction and expansions specified in manufacturer's latest published literature.

4. Gaskets: Mechanical grooved coupling design, pressure responsive so that internal pressure serves to increase the seal's tightness, constructed of elastomers having properties as designated by ASTM D2000.
   a. Water Services: EDPM Grade E, with green color-code identification.
   b. Other Services: As recommended by Manufacturer.
5. Bolts and Nuts: Heat-treated carbon steel, ASTM A183, minimum tensile 110,000 psi. (Exposed locations require tamper resistant nuts).
6. Branch Stub-ins: Upper housing with fill locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts.
7. Fittings: Grooved or shouldered end design to accept grooved mechanical couplings.
   a. Malleable Iron: ASTM A47
   b. Ductile Iron: ASTM A536
   c. Fabricated Steel: ASTM A53, carbon steel, Schedule 40, Type F, for 3/4 inch to 4 inch; Type E or S, Grade B for 5 inch to 20 inch.
   d. Steel: ASTM A234
   e. Wrought Copper and Bronze: ASTM B75 tube and ASTM B584 bronze castings.
   f. Galvanized: ASTM A106, ASTM A46, or A536. Couplings for use with AWWA dimension piping shall conform to AWWA C606.
8. Flanges: Conform to Class 125 cast iron and Class 150 steel bolt holes alignment.
   a. Malleable Iron: ASTM A47.
   b. Ductile Iron: ASTM A536.
9. Grooves: Conform to the following:
   a. Standard Steel: Square cut.
   b. Lightweight Steel: Roll grooved.
   c. Cast Iron: Radius cut grooved, AWWA C606.

H. Miscellaneous Piping Materials/Products:
1. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
2. Soldering Materials: Lead-free solder
3. Brazing Materials: Except as otherwise indicated, provide brazing materials to comply with installation requirements.
   a. Comply with AWS A5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.
      1) Copper phosphorus – Bcup
      2) Silver - BAg minimum 4% Silver content
4. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.
5. Pipe Thread Sealant Material: Except as otherwise indicated, provide all pipe threads with the sealant material as recommended by the manufacturer for the service.

I. Piping Systems:
1. Domestic Hot and Cold Water:
   a. Above Grade, Inside Buildings: Type L, hard drawn copper tube with wrought copper or bronze fittings, lead free solder joints or Schedule 40, galvanized steel pipe A53 grade B, ERW w/galvanized Grooved end fittings.
   b. Below Grade, Inside and Outside Buildings: Underground outside fittings shall comply with City of Aurora standards.
      1) 2 inches and Smaller: Type K, soft copper or Type K annealed copper tube with wrought copper fittings, silver brazed solder joints.
      2) 2.5 inches and Larger: Class 250, tar coated outside, cement lined, cast iron or ductile iron with mechanical or push on joints.
2. Equipment drain and overflows: Type "M" or "DWV" copper.
3. Sanitary Sewer and Vents:

a. Above Grade: Service weight cast iron, no-hub type with neoprene gaskets; service weight cast iron, hub and spigot type with neoprene gaskets; or DWV copper with wrought copper or cast brass fittings.
   1) Use heavy duty no hub couplings4" wide 304 stainless steel shield, with six (6) stainless steel clamps mounted in series on the following:
      a) Sanitary vent piping 4" and larger.
      b) Sanitary piping 3" and larger.
      c) All storm piping.
   2) Torque to minimum 80 inch pounds or per manufacturer's recommendation.
   3) Acceptable manufacturers: Husky Series 4000 or Mission Heavy Weight.
b. Below Grade: Sizes 2 inches to 20 inches, service weight cast iron, hub and spigot type with neoprene compression gaskets; or sizes 12 inches and larger ductile cast iron with neoprene gasket joints.
c. Cleanout Openings: Two-way type, 1-1/4 inch nominal size minimum and located such that long lines can be entered from both ends. Lubricate plugs at installation.
d. All sump pumps receiving floor drains located in boiler rooms will be non-submersible type. Pumps will be designed to handle hot water because boilers are flushed or emptied at intervals into floor sumps.

4. Storm Drain
   a. Above Grade:
      1) Same as sanitary sewer.
      2) Utilize heavy duty, 8 psi, no-hub couplings for cast iron. No-hub may only be used on piping within 20' below the roof. This limitation is to prevent a failure of the 8 psi rated couplings in the event of a downstream system blockage. In lieu of this restriction adequate relief or a higher rated fittings, must be provided and approved by the engineer.
      3) Threaded or mechanical couplings with galvanized piping are acceptable for all locations.
   b. Below Grade: Sizes 2 inch to 20 inch, service weight cast iron, hub and spigot type or sizes 12 inch and larger ductile cast iron with neoprene gasket joints.
   c. Roof drains or drains located in outside areaways, not subject to regular foot traffic, shall be of the dome type to minimize clogging with leaves or other debris.
5. Natural Gas:
   a. Within the Building: Schedule 40 black iron pipe, threaded for sizes 2 inches and smaller and welded for 2-1/2 inch and larger. All lines shall be accessible.
   b. Flex lines to equipment and fixtures shall be stainless steel with epoxy coating on both sides, UL stamped. Other types are prohibited.
   c. Pipe dope shall be Teflon based. Oil based is not permitted. Teflon tape prohibited.
6. Chemical and Acid Waste:
   a. Acid resistant, flame retardant, schedule 40 polypropylene pipe and fittings with electrically-induced or mechanical joints.

J. REFRIGERANT PIPING
1. Line sets are not allowed.
2. Tube Material:
   a. Size 3/4” and smaller: Soft annealed temper copper tube.
   b. Size 7/8” through 4-1/8”: Hard drawn temper copper tube.
   c. Type ACR.
3. Fittings: Wrought-copper, solder-joints, ANSI B16.22.
4. Joints: Brazed or soldered with material having shear strength of 10,000 PSI or greater.
5. End Caps:
   a. Provide factory applied plastic end caps on each length of pipe and tube.
   b. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.
6. Shut Off Valves:

K. Manufacturers:
1. Henry
2. Other Acceptable Manufacturers:
3. Parker Hannifin Corp.
4. Singer
5. Sporlan Valve Co.
6. Size 7/8 Inch and Smaller:
   a. Model: Series 600.
   b. Type: Pack-less diaphragm.
   c. Material: Forged bronze.
   d. Flow: Non-directional.
   e. Servicing: Diaphragm changeable under line pressure.
7. Size 1-1/8 Inch and Larger:
   a. Model: Series 200.
   b. Type: Wing cap, back seating.
   c. Material: Bronze.

L. Pipe Connectors:
1. Manufacturers
   a. Mason
   b. Metraflex
   c. Flexonics
2. Braided bronze with copper tube ends, compatible with refrigerant type for system
3. Flexible connector shall be line size or connection size, whichever is larger.

M. Piping Specialties:
1. Refrigeration Accessories (Strainers, Moisture-Liquid Indicators, Filter-Driers, Evaporator Pressure Regulators, Discharge Line Mufflers, Expansion Valves, Superheat Adjustment):
2. Manufacturers:
   a. Alco Controls Division, Emerson Electric Co.
   b. Henry Valve Co.
   c. Parker Hannifin Corp.
   d. Sporlan Valve Co.
3. Filter Drier:
   a. Conform to ARI Standard 710.
   b. Sizes ½" and larger - interchangeable core, full flow.
   c. Sizes smaller than ½" - sealed type.
   d. Minimum burst pressure - 1500 psig.
4. Expansion Valve:
5. Thermostatic type, diaphragm or bellows operated.
6. External superheat adjustment factory set for 10ºF superheat (adjustable).
7. Compatible with refrigerant type for the project.
8. Pressure rated per project requirements.
9. Power elements and valve size shall be as recommended by the manufacturer, for the service intended.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance.
1. Comply with ANSI B31 Code for Pressure Piping.

2. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment shall be allowed.
3. Use fittings for all changes in direction and all branch connections.
4. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
5. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
6. Install drainage piping with a minimum 1/8 inch per foot downward slope in the direction of the drain and a maximum slope of ¼ inch per foot.
7. Install drains at all low points in mains, risers, and branch lines consisting of a tee fitting, ¾-inch ball valve, and short ¾-inch threaded nipple, hose connection, and cap.

B. Piping System Joints:
1. General: Provide joints of type indicated in each piping system.
2. Thread pipe in accordance with ANSI B2.1Braze copper tube-and -fitting joints in accordance with ASME B31.
3. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31. Provide weld-o-let fittings for two pipe sizes less than main pipe size.
4. Weld pipe joints as follows:
    a. Weld pipe joints only when ambient temperature is above 0 degrees F. (-18 degrees C)
    b. Bevel pipe ends at a 37. 5-degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
    c. Use pipe clamps or tack-weld joints with 1-inch long welds; 4 welds for pipe sizes to 10 inch, 8 welds for pipe sizes 12 inch to 20 inch.
    d. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures, which will ensure elimination of unsound or un-fused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
    e. Do not weld-out piping system imperfections by tack-welding procedures; re-fabricate to comply with requirements.
5. Weld pipe joints of steel water pipe in accordance with AWWA C206.
6. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

C. Pipe Fittings:
1. Place unions at all equipment, regulators, controls, etc., that require removal or replacement. Do not block removal with adjacent equipment or piping. Where necessary for removal of equipment, install unions on both sides of equipment. Unions are not required on flanged devices.
2. Use dielectric waterway fittings where dissimilar metals are connected. Isolate building distribution gas piping with dielectric unions from gas main for cathodic protection.
3. All unions shall be ground joints.
4. Make reductions in size with reducing fittings.
5. All screwed nipples from copper fittings shall be red brass.

D. Pipe Connections: Install pipe connections to pumps, compressors, etc., with adequate allowance for movement and vibration. Support connections so the equipment does not carry weight.

E. Expansion Compensation: Arrange pipes and equipment with due regard for the effects of thermal expansion.

F. Hangers and Supports:
1. Maintain uniform grading and pipe slope of piping system. Install supports between piping and building structure to prevent swaying and vibration. Install hangers to provide a minimum 1/2-

inch clear space between finished covering and adjacent work. Use threaded rods with two lock nuts.

2. Do not support weight of piping from mechanical equipment, ductwork, pump flanges, coil connections, and related items.
3. Support hanger rods by coach screw rods, angle iron clips, or beam clamps. No drilling of structural members will be permitted without approval. Hanger rods shall be attached to the top of joist beams.
4. Do not bend hanger rods to provide alignment of piping offset from overhead supports.
5. Provide sway bracing every 40 feet on cast iron.
6. Hanger Spacing: Per current code.
7. Vertical Supports
   a. Cast Iron Pipe: Support at each floor, not to exceed 15 feet between supports, and at pipe base.
   b. Screwed Pipe: Support at 8 foot on center for 1-1/2 inch and smaller pipe. Support at 10 foot on center for 2-inch and larger pipe.
   c. Copper Pipe: Support at 6 foot on center for 1-1/2 inch and smaller pipe. Support 8 foot on center for 2-inch and larger pipe.
8. Trapeze Hangers: Space for smallest pipe in-group. Provide additional hanger rod at mid span where trapeze length exceeds 4 feet. Secure pipe at each trapeze with standard pipe strap. Rest un-insulated copper pipe on neoprene sleeves.

G. Pipe Joint Construction:
1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual".
2. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual". CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
3. Fill all medical gas and refrigerant pipe and fittings during brazing with an inert gas, i.e., nitrogen or carbon dioxide, to prevent formation of scale.
4. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
5. For all copper piping, ream and remove all burrs prior to making joints.
6. Threaded Joints: Conform to ANSI B1.20.1.
7. Damaged Threads: Do not use pipe with threads that are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
8. Welded Joints: Comply with the requirement in ASME Code B31.9 "Building Services piping".
9. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.2 INSTALLATION, GENERAL - SNOWMELT

A. Secure tubing to wire mesh or rebar every 4 feet along straight runs and on 180 degree turns secure at the top of the arc and on each side, 12 inches from the top of the arc,

B. Install fittings accessible for maintenance. Install tubing loops without splices, as a minimum, from the point at which the tubing enters the panel to the point at which it exists the panels.

C. Pressurize the tubing system with water or air to a pressure of 60 psig 24 hours prior to encasement in the radiant panel. Maintain pressurization during the panel installation and for a minimum of 24 hours after panel installation to ensure system integrity.

D. Label piping, vales, and equipment in accordance with 23 05 53.

E. Drain water or air from the system after leak testing the system and fill with 60 percent water and 40 percent propylene glycol water mix.

F. Do not extend pipe through expansion, construction, or working joints in concrete slab unless specifically addressed during design. Carefully coordinate expansion joints installed during or cut after concrete pour with the tubing layout and snow melt manufacturer.

G. Hydraulically balance mains. Coordinate balancing with Section 23 05 43 and include balancing information in balancing report.

3.3 INSTALLATION, GENERAL – RERIGERATION

A. Size lines for total pressure drop not to exceed 2º F saturation temperature.

B. Provide necessary flexibility for vibration and expansion with offsets and loops, not expansion joints.

C. Provide flexible connectors at all unit connections.

D. Replace air in pipe with dry nitrogen to prevent corrosion during soldering.

E. Install valves, sight glasses, filter-driers, and accessories, furnished by equipment supplier, but not factory installed.

F. Insulate all underground refrigerant lines with ½" flexible foam.
1. Use un-slit covering.
2. Cement all joints.

G. Hangers:
1. For insulated piping, provide hangers of size to fit outside insulation.
2. For non-insulated piping, provide hangers with elastomer insert to prevent damage to piping from vibration.

H. Testing:
1. Use the following procedure to test and hydrate the systems:
2. Isolate any elements which would be damaged by test pressures.
3. Test system with trace gas using an appropriate leak detector.
4. Pressure Test - System shall hold 150 psi nitrogen charge for a 24-hour period.
5. Repair or replace leaking elements of system and re-test.
6. After system has been proven to be free of leaks, evacuate it with a high efficiency vacuum pump to 2.5 mm of mercury absolute.
7. Evacuation - System shall be evacuated to 250 microns, and inspected by a University HVAC representative.
8. Break the final vacuum by charging with the correct refrigerant.

3.4 TESTING, CLEANING, AND CERTIFICATION

A. Test all piping systems in accordance with tests outlined in individual sections. Provide temporary equipment for testing, including pump and gages. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Test all new piping and parts of existing piping that have been altered extended or repaired. Submit report(s) on the results of each test.

B. Give a minimum of twenty-four hours notice to the Engineer for dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of the University Project Manager or representative of agency having jurisdiction. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.

C. Compressed air tests may be substituted for hydrostatic tests only when ambient conditions or existing building conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing.

D. Remove equipment not able to withstand test procedure during test.

E. For piping, which is to be concealed, piping shall remain uncovered until tests have been completed.

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

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

H. Potable Water Piping System:
1. Cap domestic water piping and subject piping to static water pressure of 50 psig above operating pressures or 150 psig maximum without exceeding pressure rating of piping system materials. Allow the system to remain pressurized for 4 hours. Correct leaks and loss in pressure and retest system.
2. Disinfect all domestic hot and cold water systems upon completion of final piping installation. Following disinfection, flush water from system through its extremities. Continue flushing until samples show quality is comparable with public water supply and complies with requirements of public health authority.

I. Gas Pipe Testing:
1. Test with air, nitrogen, or carbon dioxide.
2. Test piping system with a pressure 1-1/2 times the proposed maximum working pressure, but not less than 3 psig. Test systems having a volume of 10 cubic feet or less for a period of not less than 10 minutes and larger systems for a period of not less than ½ hour for each 500 cubic foot of pipe volume or fraction thereof without showing any drop in pressure.
3. Fully purge gas piping after piping has been checked.

J. Sanitary Sewer Pipe Testing:
1. Test drain, waste, and vent piping on completion of rough in. Close openings in piping system and fill with water to point of overflow but not less than 10 feet of head. Water level must not drop from 15 minutes before inspection starts through completion of inspection. Correct leaks and retest system.

K. Adjusting and Cleaning:
1. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush piping systems with clean water. Inspect each run of each system for completion of joints, supports and accessory items.
2. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.
3. Flush each new extension of existing systems, via hose connections prior to filling. Fill each new extension of existing systems with water that has the proper water treatment chemicals and in the proper quantity prior to connection, or opening valves to the main or existing system. Use chemicals that are compatible with the chemicals in the existing system. Flush each new system with the university representative present. Fill each new system with the proper chemicals, and with the university representative present.

3.5 COMMISSIONING (DEMONSTRATION)
1. Fill system and perform initial chemical treatment.

2. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
3. Before operating the system, perform these steps:
4. Open valves to full open position. Close coil bypass valves.
5. Remove and clean strainers.
6. Check pump for proper rotation and proper wiring.
7. Set automatic fill valves for required system pressure.
8. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
9. Set temperature controls so all coils are calling for full flow.
10. Check operation of automatic bypass valve.
11. Check and set operating temperature of converters and chillers to design requirements.
12. Lubricate motors and bearings.

END OF SECTION 23 20 00

SECTION 23 21 00 - HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Design piping systems with drain valves at low points of piping, bases of vertical risers, and at equipment.

B. In hydronic systems subject to freezing provide Dowfrost solution or pumped coils.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Valves:
      a. Automatic Fill Valves:
         1) ITT Bell and Gossett, Model B7-12
         2) Amtrol, Model 11F

2.2 MATERIALS, GENERAL

A. Piping and Fittings:
   1. General: Working pressure and temperature maximums, 125 psi and 250 degrees F; water service.
   2. Copper Pipe: ASTM B88-96, copper tubing, hard drawn, Type K for underground lines and Type L for above ground lines.
      a. Fittings: ASME B16.22-95, wrought copper solder joint.
      b. Joining Material:
         1) Solder: ASTM B32-96, 95-5 tin-antimony solder for above ground lines.
         2) Brazing: AWS A5.8-92, Classification BAg 1 (silver) for underground lines and where copper pipe is connected to brass.
      c. Unions: ASME B16.22-95. Wrought copper solder joint, ground seat.
      d. Flanges: Class 125, cast iron or cast bronze flanges.
         1) Bolts and Nuts: ASME B18.2.1-96, carbon steel square head machine bolts with galvanized heavy hex nuts.
         2) Gaskets: ASME B16.21-92, nonmetallic, flat, 1/16-inch, full faced, for water service.
      e. Dielectric Connections: Fittings having insulating material isolating joined dissimilar metals.
         1) Dielectric Waterway Fittings: 175 psi minimum working pressure, ends to match connections.
         2) Flanges: Class 125, cast bronze, ASME Standard, with bolt insulators, dielectric gasket, bolts, and nuts.
   3. Steel Pipe: ASTM A53-96, Schedule 40, seamless black steel pipe.
      a. Fittings:
         1) Threaded: ASME B16.4-92, Class 125, cast iron, or ASME B16.3-92, Class 150, malleable-iron. Standard pattern for threaded joints. Threads shall conform to ASME B1.20.1-83.
         2) Flanged: ASME B16.1-89, Class 125, cast iron, raised ground face, bolt holes spot faced.
         3) Welded: ASTM A234-96, standard weight, butt weld, black iron.
         4) Grooved Couplings and Mechanical Fittings: ASTM A536-84 ductile or ASTM A47-90 malleable iron, with enamel finish and grooves or shoulders designed to

accept grooved couplings. Synthetic-rubber gasket, with central-cavity, pressure-responsive design, and ASTM A183-83 carbon-steel bolts and nuts.

b. Unions: ASME B16.39-86, malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

c. Dielectric Waterway Fittings : Threaded end connections. Install to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.

B. Valves:

1. Safety Relief Valves:
   a. Brass or bronze body with brass and rubber, wetted, internal working parts. Valves designed, built, rated, and stamped in accordance with ASME.
2. Automatic Fill Valve: Diaphragm operated, cast brass body, fill valve designed to maintain water pressure in a closed water system. Valves shall include cleanable strainer, removable seat assembly, and built-in check valve. Valves shall have factory setting of 12 psig with field adjustment range of 10 - 25 psig. Maximum operating temperature shall be 225 degrees F, maximum working pressure of 125 psig. Valve shall have 3/4-inch inlet and outlet.

C. Piping Accessories:

1. Drain Pans: Minimum 18-gauge stainless steel, reinforced to support weight of drain pan and water.

D. Expansion Loop Guides:

1. Factory fabricated cast steel, consisting of bolted two-section outer cylinder and base. Provide two-section alignment guide spider that bolts tightly to pipe.

E. Air Separator:

1. In-Line Air Separator: Heavy duty cast iron air separator constructed for 175 psi minimum working pressure and 300 degree F. Integral weir to maximize air separation. Top outlet connection for air vent and bottom connection for expansion tank.
2. Centrifugal Air Separator: Welded steel tank, ASME constructed and labeled for 125 psig minimum working pressure and 350 degree F maximum operating temperature. In-the-pipeline type air separator with tangential openings for water in and out. Inside designed to create a low velocity vortex for the separation of free air from the water stream. Internal steel strainer with perforations sized for water flow. 2-inch bottom drain and 1-1/4-inch connection located at top of air separator for expansion tank connection.

F. Diaphragm Expansion Tank:

1. Welded steel tank suitable for 125 psig working pressure and 350 degrees F maximum operating temperature. Separate air charge from system water by means of a flexible diaphragm sealed into tank. Tank shall have taps for pressure gauge, air charge fitting, and drain. Tank constructed, tested, and labeled in accordance with ASME Pressure Vessel Code-95.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Copper Pipe:

1. Install Type L copper pipe with wrought copper fittings and solder joints for 2-inch and smaller pipe, above ground, within building.
2. Install Type K copper pipe for 2 inch and smaller pipe below ground.

B. Steel Pipe:

1. Threaded Joints: Install steel pipe with threaded joints and fittings for 2-inch and smaller in exposed locations such as mechanical rooms.
2. Welded and Flanged Joints: Install welded fittings on pipe 2-1/2 inches and larger.

3. Grooved Couplings and Mechanical Fittings: Install mechanical grooved end pipe on condenser water piping.

C. Arrange piping in horizontal groups, each group to be in one plane. Maintain indicated slope. Conceal pipe installations in walls, pipe chases, utility spaces, mechanical rooms, above ceilings, below grade or floors.

D. Install piping in accordance with the stipulations in Section 01040..

E. Sloping, Air Venting, and Draining:
1. Install piping true to line and grade, and free of traps and air pockets. Slope piping up in direction of flow at 0.2 percent grade.
2. Provide eccentric reducers for changes in horizontal piping, top side flat.
3. Connect branch piping to bottom of mains, except for up-feed risers which shall have take-off out top of main.
4. Install manual air vents at high points in hydronic piping systems and at coils other than air handling units. Provide 1/4-inch copper, 180-degree bend pipe to discharge vented water into can.
5. Install automatic air vent on air separator, water coils at air handling units, and where shown. Provide valved inlet and discharge piped to floor drain.
6. Install drain valves with hose adapters at low points in mains, risers, and branch lines. Drain shall consist of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap. Provide drain valves for float type controllers.

F. Fittings: Standard manufactured fittings. Field fabricated fittings and bushings are prohibited on all piping.

G. Unions: Install unions in pipes 2-inch and smaller, adjacent to each valve, at final connections of each piece of equipment and elsewhere to permit alterations and repairs. Install dielectric waterway fittings to join dissimilar metals. Unions are not required on flanged devices.

H. Flanges: Install flanges on valves and equipment having 2-1/2-inch and larger connections.

I. Pipe Ends: Cut pipes, remove burrs and prepare ends with full inside diameter.

J. Joints:
1. Threaded Joints: Apply Teflon tape to male equipment threads. Do not use pipe with threads which are corroded or damaged.
2. Soldered Joints: Comply with procedures contained in AWS Soldering Manual-98. Clean surfaces to be joined of oil, grease, rust, and oxides. Clean socket of fitting and end of pipe with emery cloth. After cleaning and before assembly or heating, apply flux to joint surface and spread evenly.

K. Keep openings in piping closed during construction to prevent entrance of foreign matter.

L. Install stainless steel flexible connectors at inlet and discharge connections to base-mounted pumps and other vibration producing equipment.

M. Valves:
1. Field check valves for packing and lubricant. Replace leaking packing. Service valves with lubricant for smooth and proper operation before placing in service.
2. Install valves accessible from floor level, located for easy access. Install valves in horizontal piping with stem at or above center of pipe. Install valves in position to allow full stem movement. Provide operating handles for valves and cocks without integral operators.
3. Provide extended valve stems where insulation is specified.
4. Provide separate support where necessary.

5. Where soldered end connections are used for valves, use solder having a melting point below 840 degrees F for gate, globe, and check valves; below 421 degrees F for ball valves.
6. Provide valves same size as line size.
7. Provide gate blow-down valves and hose adapters at strainers; same size as strainer blow-off connection.
8. Provide mechanical actuators with chain operators where valves 2-1/2 inches and larger are mounted more than 6 feet above the floor. Extend chains to elevation of 5 feet above floor.
9. Check Valves: Install wafer or lift check valves on pump discharge. Install check valves for proper direction of flow as follows:
    a. Swing Check Valve: Horizontal position with hinge pin level.
    b. Wafer Check Valve: Horizontal or vertical position, between flanges.
    c. Lift Check Valves: With stem upright and plumb.

N. Equipment Piping:
1. Provide combination balancing and shutoff valves to regulate water flow through piping, coils, and at other equipment and piping where shown or required for proportioning flow.
2. Install automatic fill valve in cold water make-up to boilers and chillers. Install three-valve bypass with globe valve around automatic fill valve for quick filling system. Install backflow preventers upstream of fill valve and bypass.

O. Expansion Loops, Guides, and Anchors:
1. Install piping with provisions for expansion and contraction, using expansion loops. Provide for expansion and contraction in mains, risers, and run-outs. Install pipe expansion loops cold-sprung in tension for piping with operating temperatures higher than installed temperature and compression for piping with operating temperatures lower than installed temperatures. Install pipe to absorb 50 percent of total compression or tension produced during anticipated change in temperature. Do not bend piping without use of bending machine.
2. Install guides to properly direct pipe movement into expansion loops and offsets.
3. Install anchors to control movement in piping. Weld anchors to ferrous piping and braze anchors to nonferrous piping. Install pipe anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops.
4. Install in accordance with standards of Expansion Joint Manufacturer's Association, EJMA-93.

P. Drain Pans:
1. Provide drain pans under the entire length of any piping, including valves, joints, and fittings for any liquid-carrying piping system installed over any motor, motor starter, switch gear, transformer, or other electrical equipment. Also, under all such piping located anywhere in any transformer vault, electrical switchboard room, and telephone equipment room. Drain pans shall be not less than 2 inches deep, with a 3/4-inch drain pipe to discharge where shown or to discharge at nearest convenient drain line, floor drain, or other approved drain point.

Q. Expansion Tank and Air Separator Installation:
1. Install tanks as shown; locate appurtenances for easy servicing.
2. Install gate valve and union on air separator drain to facilitate removal of strainer. Route discharge on air separator tank to nearest drain.
3. Check expansion tank after cleaning, testing, and filling of system to ensure system is completely full.
4. Provide bracket supports, saddles, and hangers to support tanks.
5. Install air separator level in both directions, supported from structure so that all pipe can be removed without moving tank.
6. Charge expansion tank with proper air charge.

3.2 TESTING, CLEANING AND CERTIFICATION

A. Test piping systems using ambient temperature water, except where there is risk of damage due to freezing.

B. Release trapped air while filling system using vents at high points. Use drains installed at low points for complete removal of liquid.

C. Isolate equipment and parts that cannot withstand test pressures.

D. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test.

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

F. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

G. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

H. Prepare written report of testing, indicating locations of leaks corrected, method used to correct leaks, number of tests required, and certification that system is leak free.

3.3 COMMISSIONING (DEMONSTRATION)

A. Provide 2 hours of instruction on hydronic systems. Include following items as a minimum:
   1. Location of automatic and manual air vents.
   2. Location of strainers and blow down valves.
   3. Location of safety and relief valves.
   4. System drain valves.
   5. System fill and associated devices.
   6. Expansion tank and air separator.

END OF SECTION 23 21 00

SECTION 23 21 13 - PRE-INSULATED PIPING

PART 1 - GENERAL

1.1 QUALIFICATIONS

A. The system supplier for preinsulated piping systems shall have fabricated systems of the composition defined herein for at least five years.

B. Acceptable Manufacturers:
1. Perma-Pipe/Ricwil
2. Thermacor Process Incorporated

PART 2 - PRODUCTS

2.1 PREINSULATED PIPING SYSTEM – CHILLED WATER SUPPLY AND RETURN

A. General Description:
1. Preinsulated piping systems shall be provided for all underground chilled water piping.
2. A preinsulated piping system consists of carrier pipe, insulation, protective jacket, connectors, supports, and appropriate fittings.
3. All underground chilled water pipes with fluid temperatures up to 60 degrees shall utilize polyurethane foam insulation with HDPE jacketing.
4. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and beveling is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.
5. Each system layout shall be computer analyzed by the piping system manufacturer to determine stresses, anchor forces, heat losses, and anticipated movements of the service pipe along the entire length of pipe. The conditions for analysis are as follows: installation temperature of 0ºF, ambient temperature of 50ºF, depth of soil cover is 10 feet, soil conductivity of 10.00 btu-in/sq.ft H-F, and a service line operating temperature of 48ºF. Friction between the ground and the jacketing material must be taken into account for the anchor force and stress calculations.
6. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

B. Service Pipe:
1. Internal piping shall be ASTM A-53, Grade B, ERW carbon steal. Schedule 40 for sizes through 10 inch, 0.375-inch wall thickness for sizes 12 inch and over (standard). Domestically produced pipe is required.
2. All joints shall be butt-welded for sizes 2-1/2 inches and larger, and socket welded for 2 inches and smaller.
3. Where possible, straight sections shall be supplied in35+foot double random lengths with sufficient piping exposed at each end for field joint welding and fabrication.

C. Accessories:
1. End seals, fittings and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation, and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.

D. Insulation:

1. Service pipe insulation (polyurethane foam) for straight sections shall be spray applied or injected such that the final foam product has a nominal 2-3 pound per cubic foot density, 90% minimum closed cell content, conforms to ASTM C-591, and has an initial K factor less than or equal to 0.16. Performed polyurethane foam for fittings is acceptable.
2. To ensure no voids are present, all insulation shall be inspected by one of the following two methods: visually checked prior to application of the protective jacket, infrared inspection of the entire length during the foaming process. After successful completion of testing, all test report documents shall be submitted to the university for records.
3. The insulation shall be applied to the minimum thickness specified below. The insulation thickness shall not be less than indicated in these specifications.

Nominal Pipe Size	Insulation Thickness
<14”	1”
14”+	1-1/2”

E. Protective Jacket:
1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

Jacket O.D.	Jacket Thickness
O.D. < 12”	0.125”
12”, O.D.< 24”	0.150”
O.D.>24”	0.175”

3. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue, or hot air welds.

F. Field Joints:
1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:
    1) The field joints are pressure tested and inspected for leaks.
    2) A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
    3) Two-part polyurethane foam is mixed properly and poured into the holes on the top of the split sleeve.
    4) After the foam insulation has expanded and cured, any excess foam shall be removed.
    5) An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3” on each side. This 3” overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve or tape.
    6) Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
    7) Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).
    8) Backfilling of the trench shall not begin until the area has cooled to the touch.
3. The piping systems manufacturer shall furnish all the foam insulation, split sleeves, and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas, and mastic materials.

2.2 PREINSULATED PIPING SYSTEMS – STEAM CONDENSATE RETURN

A. General Description:

1. Preinsulated piping system shall be provided for all underground steam condensate piping.
2. A preinsulated piping system consists of carrier pipe, insulation, protective jacket, connectors, supports, and appropriate fittings.
3. All underground steam condensate return pipes with fluid temperatures up to 200 degrees shall utilize polyurethane foam insulation with HDPE jacketing.
4. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and believing is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.
5. Each system layout shall be computer analyzed by the piping systems manufacturer to determine stresses, anchor forces, heat losses, and anticipated movements of the service pipe along the entire length of pipe. The conditions for analysis are as follows: installation temperature of 0ºF, ambient temperature of 50ºF, depth of soil cover is 10 feet, soil conductivity of 10.00 btu-in/sq.ft H-F, and a service line operating temperature of 200ºF. Friction between the ground and the jacketing material must be taken into account for the anchor force and stress calculations.
6. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

B. Service Pipe:
1. Internal piping shall be ASTM A-53, Grade B, ERW seamless carbon steel. Schedule 80 for sizes through 8 inch, 0.500-inch wall thickness for sizes 10 inches and over (extra strong). Domestically produced pipe is required.
2. All joints shall be butt-welded for sizes 2-1/2 inches and larger, and socket welded for 2 inches and smaller.
3. Where possible, straight sections shall be supplied in 35+ foot double random lengths with sufficient piping exposed at each end for field joint welding and fabrication.

C. Accessories:
1. End seals, fittings and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.

D. Insulation:
1. Service pipe insulation (polyurethane foam) for straight sections shall be spray applied or injected such that the final foam product has a nominal 2-3 pound per cubic foot density, 90% minimum closed cell content, conforms to ASTM C-591, and has an initial K factor less than or equal to 0.16. Preformed polyurethane foam for fittings is acceptable.
2. To ensure no voids are present, all insulation shall be inspected by one of the following two methods: visually checked prior to application of the protective jacket, infrared inspection of the entire length during the foaming process. After successful completion of testing, all test report documents shall be submitted to the university for records.
3. The insulation shall be applied to the minimum thickness specified below. The insulation thickness shall not be less than indicated in these specifications.

Nominal Pipe Size	Insulation Thickness
< 8”	1-1/2”
10”+	2”

E. Protective Jacket:
1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

Jacket O.D.	Jacket Thickness
O.D. < 12”	0.125”

12”<O.D.<24”	0.150”
O.D.>24”	0.175”

3. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue or hot air welds.

F. Field Joints:
1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:
   a. The field joints are pressure tested and inspected for leaks.
   b. A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
   c. Two-part polyurethane foam is mixed properly and poured into holes on the top of the split sleeve.
   d. After the foam insulation has expanded and cured, any excess foam shall be removed.
   e. An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3” on each side. This 3” overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve of tape.
   f. Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
   g. Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).
   h. Backfilling of the trench shall not begin until the area has cooled to the touch.
3. The piping systems manufacturer shall furnish all the foam insulation, split sleeves, and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas, and mastic materials.

2.3 PREINSULATED PIPING SYSTEMS-STEAM

A. General Description:
1. Preinsulated piping systems shall be provided for all underground steam piping.
2. A preinsulated piping system consists of carrier pipe, carrier pipe insulation, steel casing pipe, casing pipe insulation, HDPE casing pipe insulation protective jacket, connectors, supports, internal moment guides, and appropriate fittings.
3. All underground steam distribution pipes with fluid temperatures up to 355ºF shall utilize mineral wool carrier pipe insulation, steel conduit, and polyurethane foam conduit insulation with HDPE jacketing.
4. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and beveling is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.
5. Each system layout shall be computer analyzed by the piping system manufacturer to determine stresses, anchor forces, heat losses, conduit/polyurethane insulation interface temperature, and anticipated movements of the service pipe and conduit along the entire length of pipe. The conditions for analysis are as follows: installation temperature of 0ºF, ambient temperature of 50º F, depth of soil cover is 10 feet, soil conductivity of 10.00 btu-in/sq.ft H-F, and a service line operating temperature of 355ºF. Friction between the ground and the jacketing material must be taken into account for the anchor force and stress calculations.
6. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

B. Service Pipe:
1. Internal piping shall be ASTM A-53, Grade B, ERW Carbon steel. Schedule 40 for sizes through 10 inch, 0.375-inch wall thickness for sizes 12 inches and over (standard). Coated pipe is not acceptable. Domestically produced pipe is required.
2. All joints shall be butt-welded for sizes 2-1/2 inches and larger, and socket welded for 2 inches and smaller.
3. Where possible, straight sections shall be supplied in 35+ foot double random lengths with sufficient piping exposed at each end for field joint welding and fabrication.

C. Subassemblies:
1. End seals, gland seals, internal moment guides, fittings (tees and elbows), and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation, and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.
2. All subassemblies shall be designed to allow for complete draining and drying of the conduit system.

D. Service Pipe Insulation:
1. Carrier pipe insulation shall be mineral wool in non-supported sections. Split insulation shall be held in place by stainless steel bands installed on 18 inch centers, or two bands per insulation section, whichever is closest together. The insulation shall have passed the most recent boiling tests and other requirements specified in the Federal Agency Guidelines.
2. Support/guide sections shall have calcium silicate of the same thickness as the mineral wool with a protective sheet metal sleeve attached to the calcium silicate with screws.
3. The minimum insulation thickness shall not be less than indicated in these specifications.

Nominal Pipe Size	Minimum Insulation Thickness
2”-4”	1.5”
6”-10”	2.0”
12”-14”	2.5”
16”-20”	3.0”

E. Outer Conduit:
1. The steel conduit casing shall be a smooth wall, welded steel conduit of the thick nesses specified below:

Nominal Conduit Size	Minimum Conduit Thickness
6”-26”	10 Gauge (0.1345”)
28”-36”	6 Gauge (0.1943”)
38”-42”	4 Gauge (0.2242”)

2. Changes in casing size, as required to allow for carrier pipe expansion into the conduit, shall be accomplished by eccentric and/or concentric fittings and shall provide for continuous drainage of the conduit along the entire length of pipe.

F. Pipe Supports and Guides:
1. All pipes within the outer casing shall be supported at not more than 10-foot intervals.
2. The supports shall be designed to allow for continuous airflow and drainage of the conduit.
3. The carrier pipe supports in straight runs shall be designed to occupy not more than 10% of the annular air space between the carrier pipe insulation and the steel conduit.
4. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. Support/guide sections shall have calcium silicate of the same thickness as the mineral wool with a protective sheet metal sleeve attached to the calcium silicate with screws. This sleeve shall be as long as the corrugated supports, with a minimum length of 12 inches.
5. The corrugated metal supports shall be a minimum of 12” long and of sufficient strength (thickness) to support the pipe without the annular air space being encroached upon.

6. Moment guides and rotational arrestors internal to the outer conduit shall be provided on the locations shown on the drawings and additionally where requires by the manufacturer's analysis.

G. Outer Conduit Insulation:
1. Outer conduit insulation (polyurethane foam) for straight sections shall be spray applied or injected such that the final foam product has a nominal 2-3 pound per cubic foot density, 90% minimum closed sell content, conforms to ASRM C-591, and has an initial K factor less than or equal to 0.16. Preformed polyurethane foam for fittings (elbows and tees) is acceptable.
2. To ensure no voids are present, all insulation shall be inspected by one of the following two methods: visually checked prior to application of the protective jacket, infrared inspection of the entire length during the foaming process. After successful completion of testing, all test report documents shall be submitted to the university for records.
3. The insulation shall be applied to the minimum thickness of 1-1/2 inches. The insulation thickness shall not be less than indicated in these specifications.

H. Protective Jacket
1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue, or hot air welds.
3. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

Jacket O.D.	Jacket Thickness
O.D.<12"	0.125"
12"<O.D.<24"	0.150"
O.D.>24"	0.175"

I. Field Joints
1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:
   a. The welds on the carrier pipe field joints are pressure testes and inspected for leaks.
   b. Shipping supports on the ends of the pipe sections are cut off.
   c. Mineral wool insulation (matching the properties of the straight sections) is applied to the joint area and secured in place using stainless steel bands.
   d. A split metal casing is welded to the conduit and each other to form a pressure testable seal around the conduit. This area should allow water to drain freely past the field joint are and not become trapped in a low spot in the conduit.
   e. A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
   f. Two-part polyurethane foam is mixed properly and poured into the holes on the top of the split sleeve.
   g. After the foam insulation has expanded and cured, any excess foam shall be removed.
   h. An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3" on each side. This 3" overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve or tape.
   i. Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
   j. Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).

k. Backfilling pf the trench shall not begin until the area has cooled to the touch.

3. The piping systems manufacturer shall furnish all the mineral wool and foam insulation materials, split metal casing, stainless steel bands, split sleeves, and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas, and mastic materials.

PART 3 - EXECUTION

3.1 PREINSULATED PIPING SYSTEM

A. Installation:

1. Provide the service of a manufacturer's representative to instruct the contractor on the installation procedures of the piping system and to be present on site to assist during critical stages of installation and testing. The representative must be qualified by the piping system manufacturer who's responsibility is to provide Field Technical Assistance (FTA).
2. When the manufacturer's representative is on-site, a report shall be produced consisting of the installation log indicating actually installed conditions, field observations, and pressure test results signed by the manufacturer's representative, the contractor, and the engineer's representative. Include documentation by the manufacturer's representative that the installations in conformance with the manufacturer's recommendations.
3. A minimum of six inches (6") of sand or fine gravel bedding shall be placed all around the pipe in the trench. This bedding/fill shall be hand tamped and compacted around the pipes in six-inch (6") lifts until the fill is six inches (6") above the top of the jacketing material. The remaining height of the trench shall be evenly and continuously backfilled and compacted in uniform six inch (6") lifts with suitable clean excavated soil.
4. The field joints shall be installed as described in each product section.

B. Testing – Chilled Water and Condensate Piping

1. The internal pipe shall be hydrostatically tested to 150 psig or 1-1/2 times the operating pressure, whichever is greater. The hydrostatic test pressure shall be held for no less than one hour. In large diameter pipes, pneumatic testing may be an acceptable alternative (at the discretion of the Engineer and the university). Proper safety precautions and coordination must be completes with the university Health and Safety department before testing is initiated.
2. Testing – Welds
   a. Xray first three welds.
   b. If first three pass, X-ray every 10th weld. If failure, xray previous 2 welds after the 10th weld.
   c. After each x-ray failure, x-ray the next three welds.
   d. All welds beyond first three plus every tenth are at no cost to the university

C. Testing – Steam Piping

1. The service piping shall be hydrostatically tested to 150 PSIG or 1-1/2 times the operating pressure, whichever is greater. The hydrostatic test pressure shall be held for no less than one hour. In large diameter pipes, pneumatic testing may be an acceptable alternative (at the discretion of the Engineer and the university). Proper safety precautions and coordination must be completes with the university Health and Safety department before testing is initiated.
2. Testing – Welds
   a. Xray first three welds.
   b. If first three pass, X-ray every 10th weld. If failure, xray previous 2 welds after the 10th weld.
   c. After each x-ray failure, x-ray the next three welds.
   d. All welds beyond first three plus every tenth are at no cost to the university.

END OF SECTION 23 21 13

SECTION 23 21 16 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Strainers:
1. Place strainers upstream of all regulators, pumps, chillers, boilers, control equipment or any other equipment, which could be damaged or rendered inoperative due to foreign matter in the piping. Provide adequate access for removal.
2. Provide parallel strainers with isolation valves on primary piping systems where operation is critical and is intended to continue during servicing. Strainers shall then be cleaned through removable caps.
3. For critical systems, provide pressure gauges to indicate loading. Consider clear see-through duplex strainers or filters for critical applications.
4. Provide single strainers with isolation valves on secondary piping systems where operation can be interrupted. Provide blowdown valves with caps on single strainers.

B. Hydronic Piping Specialties:
1. General: Provide factory fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, of if not indicated, provide proper selection as determined by installer to comply with connections, within properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

C. General Information - Gauges
1. Provide gauge cocks at all gauges for removal under operation.
2. Employ independent gauges with range twice the operating pressure across pumps, strainers, pressure reducing stations, etc.
3. Monitor all systems by the building automation system for On/Off, temperatures, and pressures.

D. Shall be made in accordance with Section 23 00 00.

1.2 QUALITY ASSURANCE

A. Codes and Standards:
1. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers other than "Y Type".
2. ASME B31.9 "Building Services Piping" for materials, products, and installation.
3. Safety valves and pressure vessels shall bear the appropriate ASME label.
4. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
5. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Air Vents (manual)
   a. Armstrong Machine Works
   b. Bell & Gossett, ITT; Fluid Handling Div.

c. Hoffman Specialty ITT, Fluid Handling Div.
d. Spirax Sarco

2. Pipe Escutcheons:
   a. Chicago Specialty Mfg. Co.
   b. Sanitary-Dash Mfg. Co.
   c. Producers Specialty & Mfg. Corp.
3. Mechanical Sleeve Seal:
   a. Thunderline Corp.
4. Fire and Smoke Barrier Penetration Seal:
   a. Dow Corning
   b. Electrical Products Div./3M
   c. Flame Stop, Inc.
5. Expansion Tanks:
   a. Diaphragm Type Expansion Tanks
      1) Amtrol, Inc.
      2) Watts.
      3) Bell and Gossett ITT; Fluid Handling Div.
6. Air Separators:
   a. Bell and Gossett ITT; Fluid Handling Div.
   b. Amtrol Inc.
   c. Armstrong Pumps, Inc.
   d. Spriax Sarco
7. Combination Pressure and Temperature Relief Valves:
   a. Amtrol, Inc.
   b. Bell and Gossett ITT; Fluid Handling Div.
   c. Watts Regulator Co
   d. Spirax Sarco
8. Low Pressure Strainers:
   a. Metraflex Co.
   b. Hoffman Specialty ITT; Fluid Handling Div.
   c. Watts Regulator Co.
   d. Spirax Sarco
9. Basket Strainers:
   a. R-P&C Valve
   b. Keckley.
   c. Metraflex
10. Pressure Reducing Valves (Water Application):
    a. Amtrol, Inc. Taco, Inc.
    b. Keckley
    c. Armstrong
11. Pump Suction Diffusers:
    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett ITT; Fluid Handling Div.
12. Diverting Fittings:
    a. Armstrong Pumps, Inc.
    b. Bell & Gossett ITT; Fluid Handling Div.
    c. Victaulic Company of America
13. Dielectric Waterway Fittings:
    a. America
    b. Epco Sales, Inc.
14. Hydronic System Safety Relief Valve:
    a. Kunkle Valve Co., Inc.
    b. Watts Regulator Co.
    c. Bell & Gossett ITT; Fluid Handling Div.
15. Pressure Regulating Valves (Steam Application):

a. Spence (preferred)
b. Hoffman Specialty ITT; Fluid Div.
c. Armstrong.

2.2 MATERIALS, GENERAL

A. Air Vents (Manual):
1. Bronze body and nonferrous internal parts; 150 psig working pressure, 212 degree F operating temperature; screwdriver or coin operated type.
2. Float Type: Brass or semi-steel body, copper float, stainless steel valve and valve seat; suitable for system operation temperature and pressure. With isolating valve.
3. Washer Type: Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.
4. Provide valve or gauge cock for isolation and repair.
5. Pipe high point manual air vents to drain. Notify Project Manager in areas where the manual vents can not be piped to drain.

B. Pipe Escutcheons:
1. General: Provide pipe escutcheons with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Oversized Holes: Provide sheet steel escutcheons, solid or split hinged.

C. Dielectric Protection:
1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
2. Use dielectric waterway fittings rather than dielectric unions
3. Installing full-port brass valves, with half-unions at the inlet and outlet, to connect steel to copper pipe is acceptable.
4. Dielectric protection fittings shall be installed in equipment rooms only.

D. Sleeves: Provide pipe sleeves of one of the following:
1. Galvanized sheet steel with lock seam joints for sleeves passing through non-load bearing or non-fire rated walls and partitions. Minimum gauges as follows:
a. Pipes 2-1/2 inch and smaller: 24 gauge.
b. Pipes 3 inch to 6 inch: 22 gauge.
c. Pipes over 6 inch: 20 gauge.
2. Schedule 40 galvanized steel pipe or cast iron pipe for sleeves passing through load bearing walls, concrete beams, fire-rated partitions, foundations, footings, and waterproof floors.
3. Insulated Pipe: Sleeves of sufficient internal diameter to install pipe and insulation and allow for free movement of pipe.
4. In finished areas where pipes are exposed, terminate sleeves flush with wall, partitions, and ceiling and extend 1 inches above finished floors.
5. Fire Protection Lines: Extend sleeves a minimum of 3 inches above finished floor.

E. Mechanical Sleeve Seals:
1. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Foundation walls only.
2.

F. Fabricated Piping Specialties:
1. Drip Pans: Fabricated from corrosion resistant sheet metal with watertight joints, and with edges turned up 2-1/2 inch. Reinforce top, either by structural angles or by rolling top over 1/4-inch steel rod. Provide hole, gasket and flange at low point for watertight joint and 1-inch drain line connection.

G. Expansion Tanks:
1. Compression Tanks: Welded carbon steel rated for 125 psig working pressure, 375 degree F maximum operating temperatures. Provide with taps in bottom of tank for tank fittings and taps in end of tank for gauge glass. Tested and labeled in accordance with ASME Pressure Vessel Code.
   a. Air Control Tank Fittings: Cast iron body, copper-plated tube, brass vent tube plug, and stainless steel ball check.
   b. Tank Drain Fitting: Brass Body, nonferrous internal parts. Fitting to admit air into compression tank drain water, and close off the system.
2. Diaphragm Type Tanks: Welded steel, rated for 125 psig working pressure, 375 degree maximum operating temperature, flexible diaphragm sealed into tank. Provide taps for pressure gauge, air charging fitting, and drain fitting. Provide with steel legs or saddles. Tested and labeled in accordance with ASME Pressure Vessel Code.

H. Air Separators:
1. In-line air separators: Cast iron for sizes 1-1/2 inch and smaller, welded steel for sizes 2 inch and larger; tested and labeled for minimum 125 psig working pressure and 350 degree F operating temperature. ASME constructed and labeled
2. Air Elimination Valve: Bronze, float operated, for 125 psig operating pressure.

I. Pressure Reducing Valves:
1. Diaphragm operated, cast iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down and non-corrosive valve seat and stem. Factory set at operating pressure and field adjustable.

J. Hydronic System Safety Relief Valves:
1. Diaphragm operated, cast iron or brass body, Teflon seat, stainless steel stem and springs, with low inlet pressure check valve, inlet strainer removable without system shut-down, ASME certified and labeled. Select valve to suit actual system pressure and BTU capacity. Set valve to relieve at 10 psi above operating pressure.

K. Unions: ANSI B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and- socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.

L. Dielectric waterway fittings: Threaded end connections installed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.

M. Automatic Air Vent:
1. Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 degree F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection. B & G Model #87.

N. Pump Suction Diffusers:
1. Cast iron body, with threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 300 degree F maximum operating temperature; and complete with the following features:
   a. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
   b. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
   c. Disposable fine mesh strainer to fit over cylinder strainer.

d. Permanent magnet located in flow stream, removable for cleaning.
e. Adjustable foot support designed to carry weight of suction piping.
f. Blowdown tapping in bottom; gauge tapping in side.

O. Diverting Fittings: Cast iron body with threaded ends or wrought copper with solder ends; 125 psig working pressure, 250 degree F maximum operating temperature. Indicate flow direction on fitting.

P. Low Pressure Y-Pattern Strainers:
1. Line size strainer with ends matching piping system materials, 125 psig working pressure with Type 304 stainless steel screens with 3/64-inch perforations at 233 per square inch.
   a. Threaded Ends, 2-Inch and Smaller: Cast iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
   b. Threaded or Flanged Ends, 2-1/2-inch and Larger: Cast iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
   c. Butt Welded Ends, 2-1/2-inch and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.
   d. Grooved Ends, 2-1/2-inch and Larger: Tee pattern, ductile-iron or malleable-iron body, and access end cap, access coupling with EDPM gasket.

Q. High Pressure Pipeline Strainers:
1. Line size with ends matching piping system materials, 250 psig working pressure with Type 304 stainless steel screens with 3/64-inch perforations at 233 per square inch.
   a. Threaded Ends, 2-Inch and Smaller: Cast iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
   b. Threaded or Flanged Ends, 2-1/2-inch and Larger: Cast iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
   c. Butt Welded Ends, 2-1/2-inch and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.
   d. 1/2-inch and Larger: Tee pattern, ductile-iron or malleable-iron body, and access end cap, access coupling with EDPM gasket.

R. Basket Strainers:
1. For 125 psig Systems or less and pipe sizes 16-inches or less: High-tensile ASTM A126B Class B cast iron, angle design, ductile iron clamped cover, flanged ends, stainless steel screen assembly, suitable gasket material, bottom threaded drain outlet.
2. For systems operating greater than 125 psig and pipe sizes greater than 16-inches: High-tensile ASTM A126 Class B cast iron, angle design, bolted cover, flanged ends, stainless steel screen assembly, suitable gasket material, bottom threaded drain outlet.

S. Gas Meter:
1. As per local utility supplier.
2. Coordinate any monitoring of meter with 23 09 00.

T. Domestic Water Meter:
1. General: Install per local utility.

U. Vacuum Breakers
1. Armstrong
2. Watts
3. Hoffman+
4. Spirax Sarco

PART 3 - .EXECUTION

3.1 INSTALLATION, GENERAL

A. General:
1. Install specialties in accordance with manufacturer's instructions to provide intended performance.
2. Support tanks inside building from building structure in accordance with manufacturer's instructions.
3. Where large air quantities can accumulate, provide enlarged air collection standpipes.
4. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
5. Provide manual air vents at system high points and as indicated with ¼" X 2" minimum copper tube to direct flow of air and fluid.
6. Provide valved drain and hose connection on strainer blow down connection.
7. Support pump fittings with floor mounted pipe and flange supports.
8. Provide relief valves on pressure tanks, low pressure side or reducing valves, heat exchangers, and expansion tanks.
9. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity.
10. Pipe relief valve outlet to nearest floor drain.
11. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
12. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or sleeve but not to insulation with set screws. Install escutcheon to cover penetration hole and flush with adjoining surface. Provide high cap type escutcheon to clear sleeve extension where sleeve extends above finished surface.
13. Dielectric waterway fittings: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.
14. Mechanical Sleeve Seals: at exterior foundation walls only
    a. Installed between sleeve and pipe.
    b. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

B. Hydronic Specialties Installation:
1. Install automatic air vents where noted.
2. Install in-line air separators in pump suction lines. Run piping to compression tank with 1/4 inch per foot (2%) upward slope towards tank. Install drain valve on units 2 inch and larger.
3. Install ball valve to isolate expansion tank for cleaning and blowdown. Install drain valve on tank for cleaning/blowdown.
4. Install separator in pump suction lines. Run piping to compression tank with 1/4 inch per foot (2%) upward slope towards tank. Install blowdown piping with ball valve, extend to nearest drain.
5. Provide sufficient number of pipe diameters to inlet of each pump as noted in detail or install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
6. Install gauge glass and cocks on end of compression tanks. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
7. Provide adequate support from structure to carry twice the weight of the tank, piping connections, fittings, and weight of water assuming a full tank of water. Do not overload building components and structural members. Coordinate concrete inserts with general contractor.

END OF SECTION 23 21 16

SECTION 23 21 23 – PUMPS

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Pumping System Design
1. Primary-secondary pumping systems are required where applicable. Provide standby pumps for primary pumps and pumps serving critical areas.
2. Design pumping systems so that the available positive head at the pump intake will be larger than the required net positive suction head at the highest possible water temperature at the pump intake.
3. The pump curve representing flow-head relationship shall intersect the system curve at design operating point.
4. Select pumps to operate at optimum efficiency.
5. Pump motor shall be non-overloading over the entire pump curve shown by the manufacturer.
6. Specify pumps with separate pump and motor shafts and replaceable couplings for all but cartridge pumps.
7. Provide mechanical shaft seals. Gland seals are not acceptable.
8. Provide duplex pumping units for sewage ejectors and for sump pumps in critical areas. Include lead/lag selector and automatic switchover in the event of failure.
9. Pumps for Softened or DI water shall have Stainless Steel Impellers

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
1. HI Compliance: Design, manufacture and install HVAC pumps in accordance with HI "Hydraulic Institute Standards".
2. UL Compliance: Design, manufacture and install HVAC pumps in accordance with UL 778 "Motor Operated Water Pumps".
3. UL and NEMA Compliance: Provide electric motors and components, which are listed and labeled by Underwriters Laboratories, and comply with NEMA standards.
4. SSPMA Compliance: Test and rate sump and sewage pumps in accordance with Sump and Sewage Pump Manufacturers Association (SSPMA) and provide certified rating seal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. In-line Circulator Pumps:
   a. Armstrong Pumps, Inc.
   b. Bell and Gossett ITT: Fluid Hanoung Div.
   c. Aurora
2. Vertical In-line Pumps:
   a. Armstrong Pumps, Inc.
   b. Bell and Gossett ITT: Fluid Handung Div.
   c. Aurora
3. Base-Mounted End Suction Pumps:
   a. Armstrong Pumps, Inc.
   b. Bell and Gossett ITT: Fluid Handung Div.
   c. Aurora
4. Positive Displacement Pumps:
   a. Viking
   b. Blackman

c. Roper
5. Vertical Suspended Sump Pumps and Sewage Ejector:
   a. Armstrong Pumps, Inc
   b. Peerless Pump
   c. Wek Pumps Co.
6. Submersible Sump Pumps and Sewage Ejectors:
   a. Weil
   b. Armstrong Pumps, Inc.
   c. Peerless Pumps

2.2 MATERIALS, GENERAL

A. Provide factory-tested pumps, thoroughly cleaned and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump is listed in the pump schedule. Provide pumps of same type by same manufacturer.

B. In-line Circulator Pumps:
1. General: Provide All pumps shall be bronze fitted.
2. Body: Cast iron with suction and discharge gauge tappings.
3. Shaft: Hardened alloy steel.
4. Bearings: Oil lubricated bronze journal bearings.
5. Seal: Mechanical with carbon seal ring and ceramic seat.
6. Motor: Non-overloading at any point on pump curve, open, drip-proof, oil lubricated journal bearings, resilient mounted construction, built-in thermal overload protection on single phase motors.
7. Coupling: Self-aligning, flexible coupling.
8. Impeller: Bronze, enclosed type, hydraulically and dynamically balanced and keyed to shaft.

C. Vertical In-Line Pumps:
1. General: All pumps shall be bronze fitted.
2. Body: Cast iron, 125 psi ANSI flanges of equal size, tappings for gauge and drain fittings.
3. Shaft: Steel with replaceable shaft sleeve.
4. Seal: Mechanical seal with ceramic seal seat.
5. Motor: Non-overloading at any point on pump curve, open, drip-proof, ball bearings, 15,000 hours bearing life, with lifting lug on top of motor.
6. Impeller: Bronze enclosed type, hydraulically and dynamically balanced, keyed to shaft and secured with locking screw.

D. Base Mounted End Suction Pump:
1. General: All pumps shall be bronze fitted.
2. Type: Horizontal mount, single-stage, flexible coupling, base mounted, designed for 175 psi working pressure.
3. Casing: Cast iron, 125 psi ANSI flanges, tappings for gauge and drain connections.
4. Shaft: Steel with replaceable shaft sleeve.
5. Bearings: Regreasable ball bearings.
6. Seal: Mechanical, with carbon seal ring and ceramic seat.
7. Motor: Open, drip-proof, regreasable ball bearings. Non-overloading at any point on the pump curve.
8. Impeller: Bronze enclosed type, hydraulically and dynamically balanced, keyed to shaft and secured with locking screw.
9. Baseplate: Structural steel with welded cross members and open grouting area.
10. Coupling: Flexible, capable of absorbing torsional vibration, equipped with coupling guard.

E. In-Line Recirculation Pumps:
1. General: Provide in-line recirculation pumps where indicated and of capacities as scheduled.

2. Type: Horizontal, oil lubricated, designed for 125 psi working pressure, 225 degree F (107 degree C) continuous water temperature and specifically designed for quiet operation.
3. Impeller: Bronze.
4. Body: Bronze or stainless steel construction.
5. Shaft: Steel, ground and polished, integral thrust collar.
6. Bearings: Two horizontal sleeve bearings designed to circulate oil.
7. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
8. Motor: Non-overloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.
9. Coupling: Self-aligning, flexible coupling.

F. Positive Displacement Pump:
1. Type: Single stage, rotary gear.
2. Pumps: Cast iron casing hardened shaft with stainless steel sleeves and mechanical seal, seal-lubricating bronze bearings and integral by-pass type adjustable relief valve.
3. Drive: flexible couplings.
4. Base: Cast iron common mounting for pump and motor with drop rim and drain tapping.

G. Vertical Suspended Sump Pump and Sewage Ejector:
1. General: Provide above pit sump pumps as indicated, of size and capacity as scheduled.
2. Pump: Cast iron shell, stainless steel impeller for sewage ejector; bronze impeller for sump pump, stainless steel shaft, two factory sealed heavy duty grease lubricated sleeve bearings, elevated thrust bearing, ceramic mechanical seal, and perforated steel strainer.
3. Provide extended tubing for grease bearing service above basin cover.
4. Provide basin cover and pump support with access/inspection cover.
5. Provide stainless steel removal system.
6. Controls:
    a. Wall mounted sump/sewage electrical control in a self containing NEMA 12 enclosure, two door type fabricated from not less than 14 gauge steel. Neoprene sponge door gasket seals sufficient to protect interior components from weather and dust. Electrical panel doors constructed from 12 gauge steel with integral latches.
    b. All external operating devices shall be dust and weather proof. Provide operating handle for main power disconnects on the front of the panel. Mount internal components of the enclosures on removable back panels. Mounting screws for components shall not be tapped in the panel enclosure. Internal wiring within and interconnecting between, the panels shall be complete and no field wiring within the panels shall be required. Self contained wiring troughs and cable raceways within the enclosures. External cable traps or wiring troughs are not permitted.
    c. Do not install pressure gauges, pressure switches, water activated devices or water lines of any sort in any electrical control panel. Panel shall include the following:
        1) Low voltage control power transformer
        2) Transformer primary and secondary shall be fused.
        3) Nameplates shall identify the piece of equipment and respective function.
        4) All pilot lights shall be of the push to test type.
        5) Lamps shall be of the filament type and shall include 3-phase calibrated, adjustable class 10 overload relay including ambient compensated thermal overloads. They shall provide differential single-phasing protection.
        6) H.O.A. for each pump.
        7) Make termination of wires and cables at designated terminal blocks only. Identify control wiring as well as terminal blocks by abbreviated legends, clearly designating the equipment with which the wiring and terminal blocks are associated. Identify all wiring with heat shrink labels.
        8) All panel wiring shall be type XHHW, stranded copper. Minimum control wire size shall be #14 AWG.

7. The pump and alarm controller shall provide full range differential control of two pumps, plus a high and low level alarm in response to an electronic, level-proportional signal. Provide automatic switchover in the event one pump fails.
8. The controller will have the capabilities of observing the level and making adjustments of the control form the face of the controller. The level will be displayed on a 40 segment LED bar graph. Level adjustments will be by means of plug-in programming pins.
9. An alarm silence push-button on the face of the controller with four LEDs across the top of the controller shall indicate the ON/OFF state of each pump and alarm control circuits.
10. Locate manual override switch on the face of the unit. This switch will allow the input level signal to be overridden to confirm the performance of the controlled equipment. The switch shall be a spring-return-to-center type with raise-auto-lower positions.
11. The controller shall measure 36 inch high by 45 inch wide by 10 inch deep. All job connections to be a clamp type barrier terminal.
12. One (1) Model A-100 submersible transducer constructed of PVC/Buna N, supported by wall or cover clamps. Transducer will start and stop pumps and give alarm function of high/low level alarm and water in wet well depth. Mercury and/or magnet type float will not be used. Alarm levels and pump start/stop settings will be field adjusted via the plug in programming pin on the control panel.
13. Provide field wiring of pumps, level transducer, moisture temperature sensor, remote alarm, and incoming power.

H. Submersible Sump Pump and Sewage Ejector:
1. General: Provide submersible sewage ejectors and sump pumps as indicated, of size and capacity as scheduled.
2. Pump: Cast iron shell, stainless steel impeller for sewage ejector; bronze impeller for sump pump, stainless steel shaft, two factory sealed heavy duty grease lubricated sleeve bearings, perforated steel strainer and seal to be a carbon rotating against a stationary ceramic seat rated for 225°F.
3. Provide extended tubing for grease bearing service above basin cover.
4. Provide basin cover and pump support with access/inspection cover.
5. Provide stainless steel removal system.
6. Controls:
    a. Wall mounted sump/sewage electrical control in a self containing NEMA 12 enclosure, two door type fabricated from not less than 14 gauge steel. Neoprene sponge door gasket seals sufficient to protect interior components from weather and dust. Electrical panel doors constructed from 12 gauge steel with integral latches.
    b. All external operating devices shall be dust and weather proof. Provide operating handle for main power disconnects on the front of the panel. Mount internal components of the enclosures on removable back panels. Mounting screws for components shall not be tapped in the panel enclosure. Internal wiring within and interconnecting between, the panels shall be complete and no field wiring within the panels shall be required. Self contained wiring troughs and cable raceways within the enclosures. External cable traps or wiring troughs are not permitted.
    c. Do not install pressure gauges, pressure switches, water activated devices or water lines of any sort in any electrical control panel. Panel shall include the following:
        1) Low voltage control power transformer
        2) Transformer primary and secondary shall be fused.
        3) Nameplates shall identify the piece of equipment and respective function.
        4) All pilot lights shall be of the push to test type.
        5) Lamps shall be of the filament type and shall include 3-phase calibrated, adjustable class 10 overload relay including ambient compensated thermal overloads. They shall provide differential single-phasing protection.
        6) H.O.A. for each pump.
        7) Make termination of wires and cables at designated terminal blocks only. Identify control wiring as well as terminal blocks by abbreviated legends, clearly designating the equipment with which the wiring and terminal blocks are associated. Identify all wiring with heat shrink labels.

8) All panel wiring shall be type XHHW, stranded copper. Minimum control wire size shall be #14 AWG.

7. The pump and alarm controller shall provide full range differential control of two pumps, plus a high and low level alarm in response to an electronic, level-proportional signal. Provide automatic switchover in the event one pump fails.
8. The controller will have the capabilities of observing the level and making adjustments of the control form the face of the controller. The level will be displayed on a 40 segment LED bar graph. Level adjustments will be by means of plug-in programming pins.
9. An alarm silence push-button on the face of the controller with four LEDs across the top of the controller shall indicate the ON/OFF state of each pump and alarm control circuits.
10. Locate manual override switch on the face of the unit. This switch will allow the input level signal to be overridden to confirm the performance of the controlled equipment. The switch shall be a spring-return-to-center type with raise-auto-lower positions.
11. The controller shall measure 36 inch high by 45 inch wide by 10 inch deep. All job connections to be a clamp type barrier terminal.
12. One (1) Model A-100 submersible transducer constructed of PVC/Buna N, supported by wall or cover clamps. Transducer will start and stop pumps and give alarm function of high/low level alarm and water in wet well depth. Mercury and/or magnet type float will not be used. Alarm levels and pump start/stop settings will be field adjusted via the plug in programming pin on the control panel.
13. Provide field wiring of pumps, level transducer, moisture temperature sensor, remote alarm, and incoming power.

I. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.

PART 3 - EXECUTION

A. Pipe drain from bases and stuffing boxes to floor drains.

B. Discharge increasers shall be concentric and located at pump discharge nozzle. Suction piping reducers shall be eccentric (flat on top) and located at pump suction nozzle. Do not use horizontal elbows at pump suction.

C. Support pumps and piping separately so that piping is not supported by pumps. Provide support under elbows on pump suction and discharge line sizes 4 inches and over.

D. Access: Arrange pumps to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

E. Install base-mounted pumps on minimum of 6 inch high concrete housekeeping pad equal or greater than 3 times total weight of pump and motor with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.

F. Install in-line pumps using continuous-thread hanger rod and vibration isolation hangers of sufficient size to support pump weight independent of piping system.

G. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer’s wiring diagram submittal to electrical installer.

H. Verify that electrical wiring installation is in accordance with manufacturer’s submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

I. Install line size isolation valves on both sides of pumps. The valve on the discharge side shall be a balancing type with “Memory Stop”.

J. Install flexible connections on suction and discharge sides of base-mounted pumps between pump casing and valves, unless grooved pipe and fittings are used.

3.2 TESTING, CLEANING, AND CERTIFICATION

A. Balance all base-mounted pumps to 1 mil Peak to Peak.

3.3 COMMISSIONING (DEMONSTRATION)

A. Training: Provide 2 hours of instruction to the university representative for each pumping system provided.

END OF SECTION 23 21 23

SECTION 23 22 13 - STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Steam Supply:
1. High pressure steam will be supplied to buildings from a central distribution system in accordance with Manual Part 3.4.
2. Steam Pressure Classifications:
   a. Low pressure steam: 15 psig and under.
   b. Medium pressure steam: 16 psig to 100 psig.
   c. High pressure steam: Above 100 psig.
3. At each building reduce steam to 15 psig, unless other pressures are required for special equipment.
4. Design pressure reducing stations with two valves in parallel for two-step control (capus pressure to medium pressure, medium pressure to low pressure) for minimum summer and maximum winter loads. Size valves for 1/3 and 2/3 capacity.
5. Provide globe valve by-pass for manual control. Size the by-pass valve so that if left unattended in an open position, the steam flow through the by-pass does not exceed the capacity of the safety relief valve selected.
6. Install air vents in all steam condensate piping high points.
7. Install drains in all steam condensate low points.

B. Process and Humidification Steam: all secondary steam systems shall utilize clean steam generators supplied by domestic water from ion exchange water softeners.

C. Condensate Return Systems
1. Condensate return shall be gravity return throughout the building.
2. Where gravity return is impossible, condensate shall be pumped via pumping traps or steam motivated condensate pumps.

D. Expansion loops are preferred over mechanical expansion devices. Where expansion loops are not practical, provide bellows type expansion devices, not mechanical seal types.

E. Flash Tanks: Do not discharge condensate drip traps above 15 psig into condensate return mains or condensate pump receivers. Design discharge into a flash tank vented into the low pressure side of the system and drip through a low pressure F & T trap to a condensate return main or receiver.

F. Welding process in accordance with Section 23 20 00.

G. Provide remote emergency shut-off valve for auto-claves and similar devices) outside of sterilizer housing. Shutoff to be accessible by user, and labeled “EMERGENCY SHUT-OFF”.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following:
1. ASME B31.9 Building Services Piping for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
2. ASME “Boiler and Pressure Vessel Code”, Section IX, “Welding and Brazing Qualification” for qualifications for welding processes and operators.
3. UMC Compliance: Fabricate and install steam and condensate piping in accordance with IAPMO “Uniform Mechanical Code.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Pressure Reducing Valves:
a. Spence Engineering Co., Inc. (preferred),
b. Fisher Controls International, Inc.,
c. Hoffman Specialty ITT
2. Condensate Return Systems:
a. Johnson, (preferred)
b. Armstrong Pumping Station,
c. Watson McDaniel,
3. Steam Traps; F&T, Inverted Bucket:
a. Armstrong Machine Works (preferred)
b. Hoffman Specialty ITT
c. Spirax Sarco.
4. Steam Traps Radiator Thermostatic Bellows:
a. Armstrong Machine Works (preferred)
b. Hoffman Specialty ITT
c. Spirax Sarco.
5. Steam Relief Valves:
a. Kunkle Valve Co., Inc., (preferred)
b. Spence
c. Watts Regulator Co.
6. Gaskets: Non-asbestos, spiral wound only.
a. Flexitalic (Preferred)
b. Garloc
7. Strainers:
a. Armstrong, (Preferred)
b. Fisher,
c. ITT,
d. Hoffman,
e. Spirax Sarco.
8. Buried Piping or piping exposed to weather: As specified in Section 23 20 00.

2.2 MATERIALS, GENERAL

A. Steam Piping – in weather protected areas:
1. High and Medium Pressure Steam Piping, (above 15 psig):
a. Piping 2 Inches and Under:
1) Pipe: ASTM A53, Grade B, Schedule 40 seamless, black steel, plain ends.
2) Fittings: Cast iron, Class 300.
3) Joints: Screwed above ground.
b. Piping 2-1/2 Inches and Over:
1) Pipe: Schedule 40 seamless, black steel, beveled ends.
2) Fittings: Schedule 40, seamless, black steel, butt weld type.
3) Flanges: 150 lb. forged steel, welded neck or SORF types.
2. Low Pressure Steam Piping (Below 15 psig):
a. Piping 2 Inches and Under:
1) Pipe: ASTM A53, Schedule 40, black steel.
2) Fittings: Screwed, cast-iron, 125 lb.; welded, forged steel socket weld type, 150 lb.
3) Joints: Screwed, above ground.
b. Piping 2-1/2 Inches and Over:
1) Pipe: ASTME A53, Schedule 40, black steel, beveled ends.
2) Fittings: Schedule 40 steel, butt weld type.

3) Flanges: 150 lb. forged steel, weld neck type.

B. Condensate Piping– in weather protected areas:
1. High and Medium Pressure Steam Condensate, (above 15 psig):
a. Piping 2 Inches and Under:
1) Pipe: ASTM A53, Schedule 80 seamless, black steel, threaded or plain ends.
2) Fittings: Cast iron, threaded, 125 lb.
b. Piping 2-1/2 Inches and Over:
1) Pipe: ASTM A53, Schedule 80 seamless, black steel, plain ends.
2) Fittings: Schedule 80, seamless, black iron, butt weld type.
3) Flanges: 150 lb. forged steel, welding neck or SORF types
2. Low Pressure Condensate Piping (less than 15 psig):
a. Piping 2 Inches and Under:
1) Pipe: ASTM A53, Schedule 80, black steel, threaded, and coupled.
2) Fittings: Screwed, cast-iron, 125 lb.; welded, forged steel socket weld type, 125 lb.
3) Joints: Screwed, above ground.
b. Piping 2-1/2 Inches and Over:
1) Pipe: ASTM A53, Schedule 80, black steel, beveled ends.
2) Fittings: Schedule 80 steel, butt weld type.
3) Flanges: 150 lb. forged steel, weld neck type.

C. Clean Steam Piping:
1.
a. Piping 2 Inches and Under:
1) Pipe: ASTM A53, Schedule 80, Type 316 stainless steel ,threaded, and coupled.
2) Fittings: Screwed, Type 316 stainless steel 125 lb.; welded, forged steel socket weld type, 125 lb.
3) Joints: Screwed, above ground.
b. Piping 2-1/2 Inches and Over:
1) Pipe: ASTM A53, Schedule 80, Type 316 stainless steel, beveled ends.
2) Fittings: Schedule 80, Type 316 stainless steel butt weld type.
3) Flanges: 150 lb. Type 316 stainless steel, weld neck type
2. Ball Valves: Full-ported, three-piece valves with threaded connections, type 316 stainless steel body and ball, TFE seats and seals.

D. Clean Condensate Piping
1. Type 316 stainless steel tubing with butt-weld fittings.
2. Ball Valves: Full-ported, three-piece valves with threaded connections, type 316 stainless steel body and ball, TFE seats and seals.

E. Safety Valves:
1. Bronze Safety Valves: Cast-bronze or forged copper body, rated for design pressure, forged copper-alloy disc; fully enclosed, cadmium-plated steel spring - and positive shutoff. Inlet and outlet shall be threaded for valves two inches and below. Larger valves shall be flanged.
2. Cast Iron Safety Valves: Cast-iron body, rated for design pressure; forged copper-alloy disc and nozzle; fully enclosed, cadmium-plated steel spring and positive shutoff; Inlet and outlet shall be threaded for valves two inches and below. Larger valves shall be flanged.
3. Stop-Check Valves Class 125 for 5 psig and below. Class 250 for higher pressures. Threaded bronze swing-checks for 5 psig and below, 2-inch and below pipe diameter. On higher pressure applications use wafer, ball-check, or spring-loaded types per system design

F. Pressure Reducing Valves:
1. Valve Characteristics: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff; cast-iron or bronze body with flanged end connections, hardened stainless-steel trim, and replaceable head and seat. Provide main head stem guide fitted with flushing and pressure-arresting device. Provide dirt cover over pilot diaphragm.

G. Sound Diffractors:
1. Flanged, cast steel body, rated design pressure.

H. Steam Traps:
1. Steam Traps: 15 psig and less:
   a. Thermostatic Traps: Cast-brass, angle-pattern body with integral union tailpiece and screw-in cap; maximum operating pressure of 25 psig; balanced-pressure, stainless-steel or monel diaphragm or bellows element and renewable, hardened stainless-steel head and seat. Provide an external Y strainer with blow-down rated for service.
   b. Float and Thermostatic Traps: ASTM A278, Class 30, cast-iron body and bolted cap; renewable, stainless-steel float mechanism with renewable, hardened stainless-steel head and seat; balanced-pressure, thermostatic air vent made with stainless-steel or monel bellows, and stainless-steel head and seat. Provide an external Y strainer with blow-down rated for service.
   c. Inverted Bucket Traps: ASTM A278, cast-iron body and cap, pressure rated for 25 psig; stainless-steel head and seat; stainless-steel valve retainer, lever, and guide pin assembly; brass or stainless-steel bucket. Provide an external Y strainer with blow-down rated for service.
2. Steam Traps: 16 psig to 125 psig:
   a. Thermostatic Traps: Class 125, bronze angle-pattern body with integral union tailpiece and screw-in cap; balanced-pressure, stainless-steel or monel bellows element and renewable, hardened stainless-steel head and seat. Provide an external Y strainer with blow-down rated for service.
   b. Float and Thermostatic Traps: ASTM A126, cast-iron body and bolted cap; renewable, stainless-steel float mechanism with renewable, hardened stainless-steel head and seat; maximum operating pressure of 125 psig; balanced-pressure, thermostatic air vent made of stainless-steel or monel bellows, and stainless-steel head and seat. Provide an external Y strainer with blow-down rated for service.
   c. Inverted Bucket Traps: Cast-iron body and cap, pressure rated for 125 psig; stainless-steel head and seat; stainless steel valve retainer, lever, and guide pin assembly; brass or stainless-steel bucket. Provide an external Y strainer with blow-down rated for service.
   d. Disk Traps: Applications 100 psig and over.

I. Air Vents:
1. Quick Vents: Cast-iron or brass body, with balanced-pressure, stainless-steel or monel thermostatic bellows, and stainless-steel heads and seats.
2. Float Vents: Cast-iron or brass body, seamless brass float, balanced-pressure, thermostatic bellows, and replaceable stainless-steel seat, float, and head.

J. Strainers:
1. Wye Pattern Strainers: Minimum 125 psig steam working pressure, cast-iron body conforming to ASTM A278, Class 30; Grade 18-8 stainless-steel screen, 20 mesh for 2-inch and smaller, and manufacturer recommended perforations for 2-1/2 inch and larger; tapped blow-off plug.
2. Basket Strainers: Minimum 125 psig steam working pressure, cast-iron body conforming to ASTM A278-93, Class 30; Grade 18-8 stainless-steel screen, flanged end connections, bolted cover.

K. Condensate Cooler:
1. ASME constructed welded steel for 150 psig working pressure. Steel shell with bronze heads, and copper tube bundle. Condensate in shell, water in tubes construction. Fabricate with tapping for vents, low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs. Provide saddles and support on steel pipe stand.

L. Condensate Movers:
1. Pumpless condensate system prepiped and skid-mounted:

a. System to include condensate receiver, pumping chamber, all stainless steel, single spring mechanism, inlet and discharge type 304 stainless steel spring loaded check valves, isolation valve, motive steam y-strainer, isolation valves, pressure gauge and site glass assembly.
b. Provide with battery operated cycle counter, motive steam pressure regulating valve and thermostatic air vent.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Piping Installation:
1. Seal pipe penetrations at building walls, valve pits, etc., with link-seal type mechanical seal with sleeve in concrete to assure watertight penetrations at exterior foundation penetrations.
2. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
3. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
4. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
5. Install piping to conserve building space and in such a manner that it will not interfere with use of space, other work or equipment.
6. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
7. Provide access panels or doors where valves and fittings are not exposed. Coordinate size and location of access doors as per prints.
8. Sloping:
a. Install steam piping at a uniform grade of one inch in 40 feet, in direction of flow. Use eccentric reducers to maintain bottom of pie level.
b. Install steam condensate piping at a uniform grade of one inch in 40 feet. Install drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
9. Where pipe support members are welded to structural building framing; scrape, brush clean, and apply one coat of zinc rich primer to welding.
10. Install branch connections to supply mains using 45 degree fittings in main with take-off out the top of the main. Use of 90 degree “tee” fittings is permissible, where the use of 45 degree fittings are not practical. Where the length of a branch take-off is less than 10 feet, pitch branch line down toward mains, 1/2 inch per 10 feet.
11. Install flanges on valves, apparatus and equipment having 2-1/2 inch and larger connections.
12. Install flexible connectors at inlet and discharge connections to pumps and other vibration producing equipment.
13. Install strainers on the supply side of each control valve, pressure regulating valve, solenoid valve, traps, and elsewhere as indicated. Install 3/4 inch NPS nipple and ball valve in blow down connection of strainers 2 inch and larger. Use same size nipple and valve as blow-off connection of strainer.
14. Drip Legs:
a. Install drip legs at low points and natural drainage points in the system, such as at the ends on mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends and expansion joints.
b. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 200 feet where pipe is pitched down in the direction of steam flow and a maximum of 150 feet where the pipe is pitched up so that condensate flow is opposite of steam flow.
c. Drip leg diameter: Same diameter as the main up to 4 inch pipe size, 4 inches in diameter for mains up to 8 inches and 1/2 of the diameter on the main thereafter.

d. Drip leg lengths: At least 1-1/2 times the diameter of the main, but never less than 10 inches for systems with supervised warm-up. For systems with automatic warm-up, the drip lengths shall be a minimum of 28 inches in length.
e. Install steam traps close to drip legs.

15. Install unions downstream of valves and at equipment or apparatus connections. Install dielectric unions where joining dissimilar materials.
16. Terminal Equipment Connections:
    a. Size pipe for supply and return same size as equipment connections.
    b. Install bypass piping with globe valve around control valve. Install only one bypass where multiple parallel control valves are installed.
    c. Install vacuum breaker downstream from control valve and bypass, and close to coil inlet connections.
    d. Pipe outlet from coils to drip legs and trap.

B. Valves:
1. Install valves with stems upright or horizontal, not inverted. Install valves in position to allow full stem movement. Locate valves for easy access.
2. Provide extended valve stems where insulation is specified.
3. Provide valves same size as line size.
4. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
5. Install globe valves for throttling, bypass, or manual flow control services.
6. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.
7. Install gate valves on drop legs, dirt pockets, and strainer blowdowns to allow removal of dirt and scale

C. Safety Valves:
1. Pipe discharge from safety valves to atmosphere outside the building.
2. Install drip-pan elbow fitting adjacent to safety valve.
3. Pipe drain connection to nearest floor drain.

D. Pressure Reducing Stations:
1. Pressure reducing stations shall have two valves sized for 1/3 and 2/3 capacity of the calculated total steam load. Switch-over between valves shall be via manual gate valves.
2. Each branch of the pressure reducing station shall include a swing-joint to accommodate component removal.
3. Install pressure-reducing valves in accessible location for maintenance and inspection.
4. Install bypass around each reducing valve, with globe valve equal in size to area of reducing valve seat ring.
5. Install gate valves and unions or flanged connection around each reducing valve.
6. Install full size strainer with blow down upstream of each reducing valve
7. Install 4½-inch pressure gauge, 0 to 200 psi on inlet side and 0 to 60 psi on medium pressure load side of station. Provide anti-siphon loop or “pig-tail” and steam-rated gauge cock. Install pressure gauges where they are clearly visible from the operating level of the reducing station.
8. Control of pressure reducing stations shall have PRVs with pilot positioners and shall fail closed Pressure reducing station failure shall also have appropriate alarms connected to the Building Automation System.

E. Steam Traps:
1. Install traps at all low points or where condensate is trapped. Install steam traps in accessible locations close to connected equipment and drip legs. Maximum allowable distance from equipment is 4 feet.
2. Install gate valves, strainer, and union upstream from trap; install union, check valve, and gate valve downstream from trap.
3. Applications 15 psig and less:
    a. Thermostatic Traps: Install on convectors and finned-tube radiation.

b. Float and Thermostatic Traps: Install on steam main and riser drip legs, laundry equipment, kitchen equipment, heat exchangers, and coils, or systems with modulated steam supply.
c. Inverted Bucket Traps: Install on steam mains and riser drip legs.

4. Applications 16 psig to 125 psig:
a. Thermostatic Traps: Install on convectors and finned-tube radiation.
b. Inverted Bucket Traps: Install on steam main and riser drip legs, laundry equipment, kitchen equipment, heat exchangers, and coils.
c. Thermodynamic Traps: Install on steam mains, riser drip legs, and heat tracer lines.

F. Flash Tanks:
1. Pitch condensate lines towards flash tank.
2. If more than one condensate line discharges into flash tank, install a swing check valve in each line.
3. Install thermostatic air vent at the top of the tank.
4. Install an inverted bucket or float and thermostatic trap at the low pressure condensate outlet, sized for triple the condensate load.
5. Install a safety relief valve at the tank top.
6. Install a pressure gage, gate valve, and swing check valve on the low pressure (flash) steam outlet.

G. Identification:
1. Label piping, valves, and equipment as specified in Section 23 05 53.

3.2 TESTING, CLEANING AND CERTIFICATION

A. Clean and flush system, with clear water, of all dirt, metal chips, sand, and foreign matter. After flushing, remove, clean, and replace all strainer baskets or screens. Inspect each run of each system for completing of joints, support, accessory items, and obvious leaks.

B. Examine and inspect piping in accordance with ANSI B31.9, Chapter VI.

C. Leak Testing:
1. Provide temporary equipment for testing, including pumps and gages. Test piping system before insulation is installed, wherever feasible, and remove control devices before testing. Subject entire steam supply and return piping systems to leak tests, either as a whole, or in sections; but leave no part untested.
2. Leak test steam supply and return piping systems complying with ANSI B31.9
3. Fill piping systems with clear water, vent all air and pressurize at 150% of design pressure, (but not less than 25 psi) for 2 hours. Test fails if leakage is observed, or pressure drop exceeds 5% of test pressure.
4. Notify Project Manager at least 5 days before performing leak tests.
5. Repair piping systems which fail required piping test, by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.
6. Drain test water from piping systems after testing and repair work has been completed.

D. Treating: Upon completion, fill, clean, and chemically treat systems. Refer to Section 23 25 00 for chemical treatment of systems.

E. Certification: Prepare written report of testing, indicating locations of leaks corrected, method used to correct leaks, umber of tests required, and certification that system is leak free.

3.3 COMMISSIONING (DEMONSTRATION)

A. Provide 4 hours of instruction on steam system. Include operation and maintenance and locations of the following as a minimum:

1. Location of traps.
2. Location of strainers and blow down valves.
3. Location of safety and relief valves.
4. System drain valves.
5. System fill and associated devices.

END OF SECTION 23 22 13

SECTION 23 25 01 - CHEMICAL WATER TREATMENT - START-UP

PART 1 - GENERAL

1.1 SUMMARY

A. This standard includes flushing, cleaning, and treating the following systems:
   1. Flushing, Cleaning, and Treating of water filled systems that interface with the CUP
   2. Flushing, Cleaning, and Treating of water filled systems that do not interface with the CUP
   3. Steam and condensate systems
   4. Pre-cleaning and passivation of condenser water and cooling tower systems

1.2 SYSTEM DESIGN REQUIREMENTS

A. Flushing, Cleaning, and Treating of Systems into the university Distribution System(s).
   1. The university Facilities Operations Department personnel are highly motivated to employ the best possible treatment practices to insure the boilers, chillers and associated piping meet or exceed their expected lifespan. The university Central Utility Plant (CUP) personnel co-ordinates the cleaning process for all Chilled Water, Heating Water, Steam, Condensate, Condenser Water, and Cooling Towers.
   2. Expansion to the distribution system of the university requires the interface of new piping with the existing piping. With this in mind, the university CUP requires that consistent cleaning and passivation practices are performed throughout the campus on all projects. The goal is for all new facilities are as follows:
      a. Insure that all systems are properly flushed, cleaned, and passivated to minimize foulants returned to the CUP when opened to the existing distribution system.
      b. Insure that the treatment practices employed are compatible with current treatment programs.
      c. Insure that pretreatment practices meet the minimum requirement of the university CUP.
   3. Due to the size of the campus chilled water system, creative approaches are being applied to the treated water to manage the inevitable conditions where various contaminants may enter the loop as a result of system expansion. The general goals will be consistent with industry standards for proper treatment of the systems on site. Below is a summary of these standards:
      a. Chilled water mild steel corrosion rates of <0.5 MPY.
      b. Chilled water copper corrosion rates of no greater than 0.1 MPY.
      c. Aerobic biological counts in the chilled water not to exceed 50,000 CFU/ml, sulfate reducing bacteria counts <10 CFUs.
      d. No scale in the chilled water system.
      e. Condensate mild steel corrosion rates of <5.0 MPY.
      f. Condensate copper corrosion rates of <0.1 MPY.
      g. Steam will contain <10 ppb of dissolved oxygen at all times.
   4. An equivalent chemical may be used after it has been approved for compatibility by the university CUP. The contractor's chemical vendor will provide data sheets to the university CUP with the request for approval for an equivalent chemical. Equivalent chemicals cannot be used until they have been approved by the university CUP.
   5. It is the contractor's responsibility to ensure that the system(s) is clean, and has been properly treated. It is the university Water Treatment contractor's responsibility to verify that the system(s) has been properly treated and is ready to be opened into the university Distribution System(s).
   6. Co-ordinate with the university CUP personnel and the current university CUP Water Treatment contractor to determine which tests and inspections will be monitored.
   7. Contact the university Outage Coordinator to schedule the opening of any/all system(s) into the same university system(s). The university Outage Coordinator must have all required paperwork on file before they will schedule a system startup.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

A. Chilled Water and Heating Water Systems

1. Chilled water piping must be pre-cleaned and passivated prior to operation. To accomplish this, a method must be provided to circulate these lines at design flow during cleaning. Design minimum flows are stated as a function of pipe diameter in the table below:

Pipe diameter in inches	Cross sectional area in feet	Minimum flow GPM for 2 ft/sec velocity
6	0.2	180
8	0.35	314
12	0.79	708
16	1.4	1256
24	3.14	2818
36	7.06	6284

2. Taps will be installed, in the vault, on the building side of the supply and return isolation valves. The building pump or temporary circulation pump will circulate the water during the pretreatment process.
3. The addition of Isothiazolin biocide is required. It needs to be added after the system cleaning has been accepted. The nitrite must be added 24 hours after the nitrite has been added.
4. During the flushing, cleaning, and treating process, insure that the minimum flow of 2 feet/second is met. Flow less than 2 feet/second is not acceptable. Flows greater than 2 feet/second, up to the maximum design flow of the system, are acceptable and will assist in the flushing, cleaning, and treating process. Maximum flow is preferred but not required.
5. If possible, on heating water systems, heat the bulk water to 120 degrees F during the circulation period.
6. The university CUP must approve all products that will be used prior to the start of the process. Only factory blended products will be considered. Products blended onsite are not allowed.
7. Biological samples can only be taken Monday through Thursday (Holidays excepted). The sample is sent overnight to the lab. Until the test results return acceptable, a system will not be allowed to be opened into the existing university Distribution system.
8. Two options exist for pre-cleaning. One approach is an alkaline based approach and the other is a nitrite based approach. Consult the university CUP prior to choosing an approach. The alkaline based pre-cleaner applies a minimum of 500 ppm of total inorganic phosphate within the treated water. The pre-cleaner should also contain detergents and dispersants designed to perform an effective cleaning at pH values of 11.5 or higher. The pretreatment plan should also include a minimum of 10 ppm of organic copper corrosion inhibitor such as “TT” in the bulk water. An alternative nitrite based approach uses nitrite, detergents, dispersants and 10 ppm of organic copper corrosion inhibitor such as “TT”. This product is applied to achieve nitrite residuals of in excess of 600 ppm as NO2. These treatment levels can be achieved by adding 2.5 gallons of Nalco-2859, or an equivalent product, to the system per 1000 gallons of system capacity.
    a. Flushing, Cleaning, and treating Chilled Water and Heating Water systems using an Alkaline Based Cleaner. Remember that the timeline below is dependent upon all things occurring as they are written. The time line below is bare bones for an average sized system. Smaller projects may be able to save some time during the filling and draining periods.
        1) Day 1: Fill the entire system that is available with city water and continuously circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run.
        2) Day 2 (24 hours after step #1): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test the water for conductivity and view the water for clarity. If there are no issues,

the university CUP will give a verbal "OK" to the contractor onsite to proceed with the drain down. This "OK" will be followed up with an e-mail to all interested parties.

3) Day 3: Refill the entire system that is available with city water and add the approved alkaline based cleaner. Your water treatment consultant will need to calculate the correct amount of cleaner needed. Circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. Run each pump at least two separate times.
4) Day 4: Continue to circulate the entire system with the cleaner in it throughout the building, including lines to vaults (If required). If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. We would like to see each pump to run two separate times.
5) Day 5 (A minimum of 48 hours after step #3 has been completed): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test water for pH and conductivity. If the pH test is above 11.5 and the conductivity is elevated well above city water conductivity, a verbal "OK" will be given that the pH of the water is acceptable and the drain down and flushing out of the cleaner can start. This "OK" will be followed up with an e-mail to all interested parties.
6) Day 6: If the following does not occur as written, all dates below this will be affected. When the conductivity is within 10% of the conductivity of the City of Aurora water, contact the university CUP. The university CUP will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and pH. If the conductivity test is within 10% of the conductivity of the City of Aurora water, a verbal "OK" will be given that it is acceptable to add the Isothiazolin biocide. Circulate the system for 24 hours and then proceed to step #7. This "OK" will be followed up with an e-mail to all interested parties.
7) Day 7 (24 hours after step #6 has been completed): Add enough of the approved inhibitor (Nitrite) to raise the level of nitrite in the system to a minimum of 600 ppm. Your water treatment consultant will need to calculate the correct amount of chemical needed.
8) Day 9 (A minimum of 48 hours after step #7 has been completed): Contact the university CUP. The university CUP and/or the university Water Treatment contractor will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and nitrite, and a biological sample will be taken and sent overnight to the lab. If the nitrite is at 600 ppm or higher and the conductivity is elevated, a verbal OK of the nitrite level will be given. If the nitrite level is low, a verbal denial will be given and more nitrite will need to be added. Conductivity will be tested to verify that the conductivity is elevated above city water conductivity. A sample for biological testing will be taken and sent overnight to the university Water Treatment contractors testing lab. We encourage you to have you water treatment consultant to have biological testing performed on the water. Ensure that the lab that performs the testing will test for aerobic, anaerobics and denitrifying bacteria.
9) Keep the system flowing until it is opened up to the university Chilled Water Distribution system.
10) When the test results become available, we will share them with all interested parties. If the sample passes the biological tests, proceed to the next step. If the sample fails one or more of the tests, we will need to met as a group and discuss re-cleaning and re-treating of the system.
11) Once the system has successfully passed all tests, schedule with university Outage Coordinator to open the system up to the university Chilled Water Distribution system.

b. Flushing, Cleaning, and treating Chilled Water and Heating Water systems using a Nitrite Based Cleaner. Remember that the timeline below is dependent upon all things occurring as they are written. The time line below is bare bones for an average sized system. Smaller projects may be able to save some time during the filling and draining periods.
   1) Day 1: Fill the entire system that is available with city water and continuously circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run.
   2) Day 2 (24 hours after step #1): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test the water for conductivity and view the water for clarity. If there are no issues, the university CUP will give a verbal "OK" to the contractor onsite to proceed with the drain down. This "OK" will be followed up with an e-mail to all interested parties.
   3) Day 3: Refill the entire system that is available with city water and add the approved nitrite based cleaner. Circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. Run each pump two separate times.
   4) Day 4: Continue to circulate the entire system with the cleaner in it throughout the building, including lines to vaults (If required). If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. We would like to see each pump to run two separate times.
   5) Day 5 (A minimum of 48 hours after step #3 has been completed): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test water for nitrite and conductivity. If the nitrite test is above 600 ppm and the conductivity is elevated above city water conductivity, a verbal "OK" will be given that the nitrite level in the water is acceptable and the bleed/fill of the nitrite based cleaner can start. With the pump still running, open a ¾" drain to a sanitary sewer and start to purge water from the system. At the same time add water to the system to replace the water that is being purged down the drain. Continue to do this until the nitrite level is down to 200 to 300 ppm. 300 ppm is preferred. DO NOT do this bleed/fill if there is nobody to monitor the process. This "OK" will be followed up with an e-mail to all interested parties.
   6) Day 6: If the following does not occur as written, all dates below this will be affected. When the nitrite level in the water is between 200 and 300 ppm, contact the university CUP. The university CUP will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and nitrite. If the nitrite is between 200 to 300 ppm, a verbal "OK" will be given that it is acceptable to add the isothiazolin biocide. Circulate the system for 24 hours and then proceed to step #7. This "OK" will be followed up with an e-mail to all interested parties.
   7) Day 7 (24 hours after step #6 has been completed): Add enough of the approved inhibitor (Nitrite) to raise the level of nitrite in the system to a minimum of 600 ppm. Your water treatment consultant will need to calculate the correct amount of chemical needed.
   8) Day 9 (A minimum of 48 hours after step #7 has been completed): Contact the university CUP and/or the university Water Treatment contractor. The university CUP will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and nitrite, and a biological sample will be taken and sent overnight to the lab. If the nitrite is at 600 ppm or higher and the conductivity is elevated, a verbal OK of the nitrite level will be given. If the nitrite level is low, a verbal denial will be given and more nitrite will need to be added. Conductivity will be tested to verify that the conductivity is elevated above city

water conductivity. A sample for biological testing will be taken and sent overnight to the university Water Treatment contractors testing lab. We encourage you to have you water treatment consultant to have biological testing performed on the water. Ensure that the lab that performs the testing will test for aerobic, anaerobics and denitrifying bacteria.

9) Keep the system flowing until it is opened up to the university Chilled Water Distribution system.
10) When the test results become available, we will share them with all interested parties. If the sample passes the biological tests, proceed to the next step. If the sample fails one or more of the tests, we will need to met as a group and discuss re-cleaning and re-treating of the system.
11) Once the system has successfully passed all tests, schedule with the university Outage Coordinator to open the system up to the university Chilled Water Distribution system.

B. Steam and condensate systems
1. Steam lines do not need to be cleaned or passivated prior to being put in-service since steam is oxygen free, and produces a non-corrosive environment. Steam blows on steam mains that are six inches in diameter or larger are required. A steam blow involves performing a series of cyclic brief venting of steam to atmosphere. The objective is to purge loose particulate material from the steam lines. Remove all strainer screens and check for debris. Clean the screens before reinstalling them. The university CUP Operations staff and/or the university Water Treatment contractor will be present to inspect a limited number of screens. Once this is accomplished the steam line may be put into service.
2. The condensate receivers will need to be initially “dumped” down the drain during the first few days of operation. Add tempering water as need to ensure that the condensate going down the drain is less than 160 F. If possible inspect the receiver for evidence of oil or organic contamination prior to putting the receiver in service. In the unlikely event that oil or organic material has contaminated the condensate receiver contact the CUP for consultation. System cleaning would be required prior to interfacing with the bulk condensate system.
3. Once the conductivity of the condensate is less than 20 and the hardness is 0.5 ppm or less, the condensate can be opened into the university Condensate System.

C. Pre-cleaning and passivation of condenser water and cooling tower systems
1. To perform an effective system cleaning and passivation, a phosphate prep is recommended. The use of N-2578 or an equivalent phosphate based cleaner is suggested to perform the procedure. N-2578 is a blend of inorganic phosphate, detergent, dispersants and organic copper corrosion inhibitors. Sufficient product should be added to the system to boost total inorganic phosphate residuals to a level in excess of 500 ppm as PO4. It is important to maintain good biological control during the passivation process. The use of an oxidizing biocide such as bromine or chlorine is not recommended since it will interfere with the passivation process. The use of a non-oxidizing biocide at a heavy dose is recommended during the passivation.
2. For most effective results, system pH must be maintained in the 7.0-7.5 range, targeting 7.25. The procedure will still work with pH as high as 8.0. If system pH rises to 8.5 the pH should be lowered by gradually adding dilute sulfuric acid. Add acid very slowly and check the pH every 30 minutes. When adding acid, gradually lower the pH into the 7.0-7.5 range, targeting 7.25. If pH goes down to 6.5, gradually add soda ash in a slurry form to raise pH into the 7.0-7.5 range, targeting 7.25.
3. DO NOT OPERATE CHILLERS IN THIS SYSTEM DURING THE CLEANING PROCEDURE.
4. When the PH of the system has been stabilized between 7.0 and 7.5, circulate the treated system at design flows through the entire system for a minimum of 8 hours. Purge all strainers in the system every hour during the pre-cleaning process. After 8 hours of circulation, shutdown the pump(s) and drain the entire system.
5. Fill and flush the entire system with city water until the flush water is clear and free of particulate material. Refill the system with city water. Perform cleaning method as follows:

a. Add a 300 ppm dose of N-2593 biocide or an equivalent to the system while circulating. N-2593 is an isothiazolin based biocide
b. Gradually add N-2578 to the system. Recommended dose is 2.5 gallons per 1000 gallons of system capacity. Check system pH and insure the concentration is in the range stated above. Contact the university Water Treatment contractor to confirm total inorganic phosphate levels are above 500 ppm
c. Continue to circulate for 24-48 hours with the system off-line and all legs of the system circulating. Check system pH once every 12 hours. Add anti-foam N-7465 as needed
d. When the cleaning is complete, drain the system several times until system conductivity is within 200 microsiemens of city water. Contact the university Chemical contractor to confirm total inorganic phosphate levels are below 10 ppm. If the phosphate level remains high, continue to drain and flush. Remove all strainer screens and check for debris. Clean the screens before reinstalling them. The university CUP Operations staff and/or the university Water Treatment contractor will be present to inspect a limited number of screens.
e. The system is now ready for normal operation with a properly run chemical treatment program. It is critical bulk water alkalinity is maintained in the 300-400 ppm range, targeting 350 ppm, in the early phases of operation. If sufficient load is not available to concentrate alkalinity we may artificially boost alkalinity into the recommended range by adding soda ash to the system.

6. Recommended ongoing treatment is using N-23208 phosphonate inhibitor, application of N-2593 isothiazolin based biocide at a 150 ppm dose weekly and the use of N-ST-20 bromine based biocide fed daily.

D. An equivalent chemical may be used after it has been approved for compatibility by the university. The contractor's chemical vendor will provide data sheets to the university with the request for approval for an equivalent chemical. Equivalent chemicals cannot be used until they have been approved by the university.

END OF SECTION 23 25 01

SECTION 23 25 13 - CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. General Information:
1. Coordinate with the university Facilities Operations for supplies and consulting. New projects should utilize the existing chemical treatment protocols.
2. Coordinate all start-ups with water treatment technician and vendor by notifying the University Project Manager.
3. Chemical treatment sites shall be over concrete dams with a retention volume equal to the volume of the chemical tank. Coordinate with the Architect to provide a curbed area for storage of on-site water treatment chemicals.
4. Separate freeze protection of systems exposed to outside air conditions into those requiring burst protection and those requiring freeze protection.
   a. Snow melt system shall be provided with 40% Dowfrost.
   b. Burst Protection: Systems that have some expansion capability and will remain dormant during the winter and will not require automatic start-up during cold weather shall be protected with concentrations of 35% Dowfrost.
   c. Freeze Protection: Systems that have no expansion capability or will require start-up during cold weather shall be protected with concentrations of 35% Dowfrost.
5. Treatment shall be as automated as possible with controllers and pumps installed in serviceable locations.

B. Hydronic Piping Systems:
1. Equip all closed water systems with a pressure pot feeder. Arrange for shot feeding or for continuous feed as appropriate.
2. Ethylene glycol is prohibited.
3. Provide ion exchange water softener for all boilers and clean steam generators capable of producing a consistent supply of make-up water containing less than 0.5 ppm total hardness. Provide a single softener vessel system for boilers that shut down at least 4 hours per day and a dual vessel system on boilers that run continuously.
4. Provide corrosion coupon racks on all chilled water, heating hot water, and condenser water systems.

C. Closed System: One bypass feeder on each system with isolating and drain valves installed around balancing valve downstream of circulating pumps.

D. Steam System:
1. Bypass feeder on feedwater line to each boiler.
2. Sequestering agent and base pumped from solution tank into boiler, condensate tank, or feedwater line near boiler. Agitator as required.
3. Oxygen scavenger pumped from solution tank into deaerator storage section, feedwater tank or feedwater line as far as possible from boiler. Pumps and agitator as required.
4. Carbon dioxide neutralizer or filming amine pumped from solution tank into steam header. Agitator as required.
5. Solution pumps shall be activated when feedwater pumps are running.
6. Conductivity controller shall sample boiler water on timed cycle and operate solenoid blowdown valve in line to blowdown tank.
7. Liquid level switch in each solution tank shall deactivate solution pump and agitator, and signal alarm.

E. Open System: Provide the system below for small open systems such as humidifiers, air washers, evaporative condensers, liquid coolers or small cooling towers.

1. Two glass-mesh feeder bags per unit, suspended in sump, filled with sequestering agent.
2. Drip feeder feeds sequestering agent into sump. Spray pump interlocked with solenoid valve on drip system.
3. Bleed-off with globe valve piped to drain located above flood line.
4. Conductivity controller samples sump water when activated by pump and operates bleed-off solenoid valve in line to drain.
5. Use automated controllers which start and start pumps to feed corrosion inhibitors, algaecide, microbicide and biocides.

F. Condenser Water Treatment: Provide the system below for medium to large systems such as cooling towers.
1. Automatic systems for inhibitor, blowdown and biocide, shall be activated by a water meter that is located on the system makeup and by a conductivity controller that has its probes located in condenser water line.
2. Sequestering agent and corrosion inhibitor pumped from solution tank into condenser water supply to tower. Agitator as required.
3. Meter feed biocide with blowdown locked out to ensure biocide retention time.
4. Conductivity controller samples water and operates solenoid bleed valve when condenser water pump is operating.
5. Biocide introduced to tower by continuous feed with solution pump or solenoid valve on tank.
6. Liquid level switch, in each solution tank, deactivates solution pump and agitator, and signals alarm.

G. Provide chemical safety data sheets for inclusion in Operation and Maintenance manuals.

1.2 QUALITY ASSURANCE

A. All services shall be performed by a qualified full-time representative. All products supplied shall meet with all regulations for safe handling and discharge into waste systems.

B. Supplier shall have 24 hour emergency spill response cleanup for any spills resulting from either the filling process or failure of the system. The individuals performing the cleanup must be OSHA certified and shall follow OSHA standards during the spill response process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Chemical Feeders:
   a. LMI
   b. Pulsafeeder
2. Chemical Treatment Water Meters:
   a. Carlon
   b. LMI
   c. Pulsafeeder
3. Conductivity Meters:
   a. LMI
   b. Pulsafeeder.
4. Pot Feeders:
   a. Neptune, Model FTF-5
5. Glycol Feeder Pressure Switch:
   a. Furnas Electric Company, Model 69WA
6. Deionized Water System:
   a. Culligan
   b. Siemens Water Technologies

c. Continental
7. Deionized Water:
   a. Carbon Filter
      1) Culligan HR-12
   b. Sediment Filter Housing:
      1) Gelman 961062
      2) or approved
   c. Storage Tank:
      1) Raven D9725
   d. Glycerine Filled Gauges:
      1) APAN LSF217
   e. Quality Monitor/Controller:
      1) Thornton 702
8. Glycol
   a. Dow Chemical Company, Dowfrost

2.2 MATERIALS, GENERAL

A. Chemical Feeders:
   1. Positive Displacement Pump: Diaphragm-type metering pump with adjustable flow rate, continuous-duty, fully enclosed electric motor and drive, and built-in relief valve. Construct pump parts in contact with chemical solution of PVC, Teflon, Viton, 316 stainless steel, polyethylene, or other corrosion resistant material.
   2. Chemical Solution Tanks: Chemical-resistant, double walled tanks sized from 60 to 110 gallons to accommodate four treatment products. Inner and outer tanks constructed of polyethylene. Provide tanks with 2 X 2-inch female threaded openings with bung and 1 X 8-inch man way fitting. Tanks shall have no fittings below liquid level. Supply tanks with transfer fittings and level indicator devices.
   3. Packaged Conductivity Controller: Micro-processor based with digital display, acceptance of 4 – 20 mA signal and capable of BACNET communications interface for building automation.
      Provide with the following control features:
      a. Conductivity control.
      b. ORP control.
      c. Inhibitor feed based on “bleed”, water meter input or percent time.
      d. Chemical time out.
      e. Dual biocide timer.
   4. Cold Water Meter: Positive displacement type with sealed, tamperproof magnetic drive; impulse contact register, single-pole, double-throw, dry-contact switch.
   5. Solenoid Valves: Forged-brass body, globe pattern, general purpose solenoid enclosure, and continuous-duty coil.

B. Pot Feeders:
   1. Bypass type chemical feeder of 5-gallon capacity, steel or cast iron construction, 125 psig working pressure. Provide a filter bag inside the feeder. Provide complete with fill funnel, 2 spare bags, shutoff valve, air release valve, and recirculation shutoff valves on inlet, outlet, and drain valve.

C. Glycol Feeder Assembly:
   1. Assembly shall consist of storage drum, feeder pump, pressure switch and low water cutoff.
   2. Glycol Tanks: Chemical-resistant 50-gallon reservoir fabricated from high density opaque polyethylene with graduated markings; molded fiberglass cover with mounting for liquid level switch, drain connection near bottom of tank.
   3. Pressure Switch: Corrosion resistant and rust proof construction, visible double break contacts which are silver-cadmium oxide, reinforced neoprene diaphragm, no-drift adjustable pressure setting, pilot duty NEMA-A600.

4. Low Water Cut-Off Switch: Switch to stop pump when water level reaches 3 inches (adjustable) above outlet supply fitting in storage drum. Switch shall also light a red warning light at the temperature control panel when activated. Label light "Glycol Storage Low Level".

D. Condenser Water Treatment Control Panel:
1. Control Panel: Solid-state integrated circuits and digital LED displays, in NEMA 250, Type 12 steel enclosure with gasket and lockable door.
2. Control dissolved solids on conductivity and include the following:
   a. LED digital readout display (micro-ohm/cm).
   b. Temperature-compensated sensor probe.
   c. HIGH, LOW, and NORMAL conductance indicator lights.
   d. HIGH or LOW conductance alarm light, trip points field adjustable, with SILENCE switch.
   e. HAND-OFF-AUTOMATIC switch for solenoid bleed valve.
   f. BLEED light to indicate valve operation.
   g. Adjustable internal hysteresis or dead band.
3. Control inhibitor feed on makeup volume and include the following:
   a. Solid-state reset counter (1 to 15, selectable).
   b. Solid-state timer (adjustable 15 seconds to 5 minutes).
   c. Test switch.
   d. HAND-OFF-AUTOMATIC switch for chemical pump.
   e. Illuminated legend shall indicate FEED when pump is activated.
   f. Solid-state lockout timer (adjustable 15 minutes to 3 hours) and indicator light. Lockout timer shall deactivate the pump and activate alarm circuits.
   g. Panel totalizer for amount of makeup.
4. Biocide programmer to include the following:
   a. 24-hour timer with 14-day skip feature
   b. Solid-state bleed lockout timer (0 to 9 hours) and biocide pump timer (0 to 2.5 hours), clock controlled.
   c. Solid state alternator to enable use of two different biocide formulations.
   d. Digital display of time of day (24 hours).
   e. Battery back-up on clock.
   f. HAND-OFF-AUTOMATIC switches for biocide pumps.
   g. BIOCIDE A and BIOCIDE B illuminated legends indicate pump running.

E. Condenser Water Filtration Assembly:
1. Filtration unit to remove suspended solids from condenser water.
2. Filter pump shall be all bronze with TEFC motor, strainer, and manual reset motor overload switch with pilot light.
3. Sand filter shall include glass-fiber-reinforced polyester tank, internal distribution piping, differential gage panel, manual and automatic pressure relief valves, backwash valve and sight tube, and graded silica sand.
4. Backwash control shall be automatic including time clocks and/or differential pressure switches, mounted in NEMA 250, Type 4 control panel. Backwash shall use city water versus system water.

F. Chemicals:
1. Chemicals compatible with piping materials, seals, and accessories.
2. Store all chemicals in a secured location on approved containment devices, with all required safety precautions. All chemicals are to be stored in a location that is warm enough to keep the chemical from freezing.
3. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
4. Biocide: Chlorine release agents or microbiocides.
5. Closed System Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.
6. Steam System Chemicals: Sequestering agent to reduce hardness and prevent feedline congestion, base to provide alkalinity, oxygen scavenger, carbon dioxide neutralizer, and filming amines.

7. Condenser Water (Cooling Tower) System Chemicals: Sequestering agent to inhibit scaling, acid to reduce alkalinity and pH, corrosion inhibitor, and biocide.
8. Open System Chemicals: Sequestering agent to inhibit scaling, acid to reduce alkalinity and pH, corrosion inhibitor, and biocide.
9. Provide quantity of extra chemicals equal to 50% of amount initially installed.
10. Provide “Material Safety Data Sheets” for all chemicals products that are onsite.

G. Glycol:
1. Dowfrost

H. Chemical Treatment Test Equipment:
1. Test Cabinet: White enamel with local fluorescent light, capable of accommodating 4 to 10 ml zeroing, titrating burettes and associated reagents.
2. Test kits shall be provided for determining water hardness and water characteristics. Test kits shall include carrying case and spare reagents. Provide as follows:
   a. Alkalinity titration.
   b. Chloride titration.
   c. Sulfite titration.
   d. Total hardness titration.
   e. Low phosphate.
   f. Conductivity bridge, range 0 to 10,000 micro-ohms.
   g. Creosol red pH slide, complete with reagent.
   h. Portable electronic conductivity meter.
   i. High nitrite.

I. Coupon Racks:
1. Constructed of 3/4 inch, schedule 80 PVC except schedule 80 mild steel pipe for hot water systems. Size coupon rack to accept four corrosion test specimens. Provide orifice valve in each rack to adjust water flow to 3 to 4 feet/second, throughout the rack.
2. Install coupon racks in condenser water systems with the warmest water supplying water to the rack.

J. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Chemical Feeders:
1. Injection point for chemicals shall be higher than top of solution supply tank to prohibit gravity feeding. Interlock conductivity controller with recirculating pump on cooling tower. Install electric solenoid valve in bleed-off line with y-strainer ahead of valve. Chemicals shall be fed into pump discharge line on continuous metered basis.

B. C. Pot Feeders:
1. 1. Install shot feeders on closed system in upright position with top of funnel not more than 48-inches above floor. Pipe drain, with ball valve, to nearest equipment drain. Install piping adjacent to equipment to allow servicing and maintenance.

C. Glycol Feeders:
1. After cleaning and flushing piping, refill glycol piping system and glycol tank with mixture of propylene glycol and water solution.
2. Perform tests to determine the strength of glycol and water solution. Submit written test results to Contracting Officer and include in maintenance manuals. Provide test prior to end of first year of operation and replenish as required.

3. Run full size discharge line from relief valve to storage tank.

3.2 TESTING, CLEANING AND CERTIFICATION

A. General: Ensure system is operational, filled, started, and vented prior to cleaning. Place terminal control valves in open position during cleaning. Add cleaning chemicals as recommended by equipment manufacturer.

B. Heating Water Systems: Hot water heating systems, including converters, pumps, coils and piping shall be cleaned with a solution of trisodium phosphate. This cleaning also applies to glycol systems prior to filling. Apply heat while circulating, slowly raising system to design temperature; maintain for a minimum of 24 hours.

C. Chilled Water Systems:

D. Steam and Condensate Systems:
1. Steam System: Fill only steam boilers with cleaner and water. Apply heat and maintain for minimum of 12 hours. Cool and drain. Refill with clean water, drain, refill, and check for sludge. Repeat until system is free of sludge. Apply heat to produce steam for piping system and maintain for minimum of 8 hours.
2. Before placing steam and condensate piping system in service, the piping shall be thoroughly blown out with steam to remove dirt, rust, scale or other contaminants. Blow down to drain or into a container all system strainers once an hour for the first 4 hours and then twice a day until the entire steam and condensate system is interfaced with the university Steam and Condensate systems. Remove all screens and clean them. The university Facilities Operation Representative will witness the inspection and cleaning of an agreed upon number of strainer screens to verify their condition.
3. Bypass traps and waste condensate until approved by the university Facilities Operations Representative. Following approval by the university Facilities Operations Representative, return condensate to collection system and put traps back in line.
4. Open System: Flush with clean water for minimum of one hour. Drain completely and refill.

E. All Systems:
1. When the flushing, cleaning, and treating process is complete, remove all startup screens from the strainer element(s), if installed.

F. Chemical Treatment:
1. System Start-Up:
   a. The water treatment supplier shall put the treatment equipment into operation, and make adjustments necessary for proper operation.
   b. The water treatment supplier shall provide a written report to the mechanical contractor indicating that all equipment is operating properly.
2. General: Test hydronic water systems one week after each system start-up and perform a second test one week after the first test. Test for total dissolved solids, inhibitors, and hardness. Provide a certified report after each test indicating initial findings, treatment required and future recommendations. Chemical treatment shall contain no chromates and be bio-degradable. Provide water analysis to determine the type and level of chemicals required for prevention of scale and corrosion.
3. Provide chemicals and service program for period of three months from project closeout. Vendor must provide “drumless delivery” (transfer of material into customer’s receiver tanks) thereby eliminating any chemical handling on the part of in-house personnel. No drums will be stored on site. Service shall include monthly analysis of water systems. Adjust treatment as needed to maintain system quality as specified. Provide written report of each visit including initial and final water tests, chemicals and amounts used. Provide 24 hour spill response capabilities.
4. Test Equipment:

a. The water treatment chemical and service supplier shall furnish basic water test equipment, including carrying case and reagents for use with the supplier's products, include apparatus for determination of treatment residual. Where specialized or supplementary equipment is required, it shall be furnished as part of the offering.
b. Provide test equipment as needed to monitor cycles of concentration and the level of treatment chemicals with the respective systems.

5. Treat raw water available at the project site to sustain the following water characteristics:
   a. Closed System:
      1) Hardness: 0.5 times the make-up water hardness.
      2) Iron: 0.0.
      3) Total Dissolved Solid: 1500 to 2400 ppm (as CaCO3).
      4) Silica: 60 ppm or less.
      5) PH: 9.6 to 10.5
   b. Steam System:
      1) Hardness: 0.0
      2) Iron: 0.0.
      3) Total Alkalinity: 1026 ppm or less.
      4) Silica: 120 ppm or less.
      5) PH 10.5 or above.
   c. Open System:
      1) Hardness: 6 times the make-up water hardness.
      2) Iron: 0.0.
      3) Total Alkalinity: 1026 ppm or less.
      4) Silica: 120 ppm or less.
      5) PH: 7.5 or above.
      6) Total Algae: 0 growth.

3.3 COMMISSIONING (DEMONSTRATION)

A. Provide the operating personnel 8 hours of instruction so as to familiarize them with all treatment equipment and procedures. Demonstrate procedure for taking weekly water test on open-loop systems and demonstrate the application and safe handling of supplied chemicals.

B. Provide a written report to the mechanical contractor indicating that operator training has been completed.

END OF SECTION 23 25 13

SECTION 23 30 00 - HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Ductwork:
1. Fiberglass ductwork is not permitted.
2. Designer should evaluate cost effective means to achieve sound alleviation in the ductwork or at the air-handling unit.
3. For larger duct systems, sheet metal cost savings can be realized by specifying different Duct Pressure Classes for the portions of the system that do not experience as much static pressure due to being farther away from the fan. Indicate on drawings the points in the ductwork system where duct construction should change because of change in Duct Pressure Class. Use the SMACNA symbol for “Point of Change in Duct Construction (by the Static Pressure Class).” Be aware of possible static pressure changes in system due to abnormal or emergency conditions.
4. Ductwork used in humidification systems to be stainless steel.
5. All exhaust ductwork used in animal housing areas to be welded stainless steel.
6. All exhaust ductwork in A/BSL-3 applications to be welded stainless steel.
7. Supply air ductwork between fan and terminal boxes (medium and high): Galvanized steel, (Grade G90 or better) shop fabricated rectangular, spiral, round or oval factory fabricated.
8. Rectangular supply air ductwork from discharge or terminal box to air devices (low pressure): Galvanized sheet metal (lined where noted on drawings); factory or shop fabricated.
9. Return air ductwork: Galvanized Steel (lined where noted on drawings): factory or shop fabricated.
10. General building exhaust ductwork: Galvanized sheet metal (lined as noted on drawings); factory or shop fabricated.
11. Transfer Ducts: Internally lined galvanized sheet metal as described above for low-pressure supplies; factory or shop fabricated.
12. Sound elbows for R.A. grilles: Galvanized sheet metal (internally lined).
13. Radioisotope exhaust ductwork: 304 stainless steel all welded construction; factory or shop fabricated.
14. Laboratory ductwork: Unlined galvanized or stainless steel ductwork as required by lab service.
15. Duct sizes on drawings shall be outside sheet metal dimensions.
16. Pressure Classifications:
    a. Low Pressure: Three pressure classifications: 1/2 inch WG positive or negative static pressure and velocities less than 2,000 fpm; 1 inch WG positive or negative static pressure and velocities less than 2,500 fpm and 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm.
    b. Medium Pressure: Three pressure classifications: 3 inch WG positive or negative static pressure and velocity less than 4,000 fpm, 4 inch WG positive static pressure and velocities greater than 2,000 fpm, 6 inch WG positive static pressure and velocities greater than 2,000 fpm.
    c. High Pressure: Positive static pressure over 6 inches WG and less than 10 inches WG and velocities greater than 2,000 fpm.
17. Air Leakage:
    a. Pressure testing of ductwork in the 3-inch and higher Duct Pressure Class is required..
18. Plenums:
    a. Obtain approval from the University Project Manager for the use and arrangement of return air plenums.
    b. Return air grilles for return air plenums shall have sound attenuation boots.

B. Duct Accessories:
1. Volume Control Dampers:

a. Show all required locations for volume control dampers in the ductwork required for air balancing. Main ducts, branch ducts, and zone ducts must have dampers to permit proper division of air quantities. Each supply branch and outlet, and each exhaust branch must have a damper control. Parallel and opposed-blade dampers shall have 4 diameters of straight duct downstream of damper. Avoid locating dampers where it is obvious they won't be needed because of the inherent pressure drops in the system due to duct layout, longest run, etc.
b. Do not install a volume damper with a frame that protrudes into an airstream due to excessive noise and pressure drop.
c. Provide locking, indicating quadrant regulators on volume control dampers.
d. Dampers that are integral parts of supply or exhaust diffusers or grilles are not permitted for balancing. Provide dampers at branches or takeoffs for balancing.

2. Take-offs:
   a. Provide conical take-offs with a manual damper if warranted. If the main duct is not deep enough for a conical fitting, specify a 45 degree fitting with a round collar.
   b. Do not put manual dampers in take-offs to VAV terminals.
3. Fire and Smoke Dampers:
   a. Provide fire and smoke dampers with a frame style that does not impinge on the duct's cross-sectional free area to decrease excessive pressure drop and noise.
   b. Provide only "dynamic" rated fire dampers.
   c. Where ventilation ductwork or grills are installed in fire rated walls or partitions install fire/smoke dampers and frames such that its fire resistance shall be equal to that of the wall or ceiling in which it is located. Size dampers to provide full duct size opening through wall, partition, or ceiling.
4. Flexible Duct:
   a. Provide flexible duct to meet the pressure class requirements.
   b. Provide a maximum length of 6 feet.

C. Air Filtration and Cleaning Devices:
1. Filter all air supplied to the building. Main building ventilation systems shall filter the air at central filter banks. Central filter banks shall have pre-filters
2. Varicel and HEPA filters shall be accessible for either upstream or downstream servicing. Pleated panel filters shall be removable from the upstream side without disturbing the filters.
3. Provide magnehelic gauges on all air handling unit filter banks.
4. Exhaust air systems, which have filters for protection of heat recovery coils, shall be 4 inch MERV 7 filters. Filters shall be easily accessible and removable through side access frames.
5. All filter doors and frames (when applicable) shall utilize closed-coil gasketing.
6. Provide extended surface high efficiency media filters where the filtering of biological organisms is required.
7. Provide activated carbon filters where odor control is required.
8. Provide filters upstream of all coils.

D. Air Terminal Devices:
1. All air flow dampers need to be far enough away from the heating coil to ensure proper heating of the air at minimum flows.
2. Design systems to minimize maintenance or service requirements in occupied spaces.
3. Provide aspirating air outlets to prevent dumping of air into occupied spaces at minimal air volumes.
4. Design system flexibility to revise zoning with minimal changes in ductwork and controls.
5. Air terminal units to be used in a healthcare, clean room or lab facility shall have a special VAV unit liner to meet health care facility standards. No exposed fiberglass in the airstream.
6. The use of fan powered VAV terminals is discouraged. Discuss application of fan powered terminals and other night low limit strategies with the University Project Manager.
7. Provide manufacturer's required upstream straight distances before airflow station.
8. Provide access panels up and downstream of reheat coils.

9. Review the Sequence of Operations for HVAC in section 23 09 93 and size coils properly for recovering from unoccupied temperatures setpoints.

E. Building Air Inlets and Outlets:
1. In buildings where exhaust air may be contaminated, locate the building air supply intake to avoid recirculation of the building exhaust air.
2. Provide air intake louvers in vertical position with a face velocity and arrangement to mitigate snow intake. Provide 1/2-inch bird screen. Maximum velocity of 500 FPM face velocity.
3. Locate air intakes as high as possible above grade. Locate bottom of air intakes minimum 20' above grade.

F. Diffusers, Registers, Grilles:
1. Indicate provisions for balancing airflow from outlets or into inlets on the drawings.
2. Provide for quantities and distribution patterns as shown on the drawings.

1.2 SUBMITTALS
1. Submit 1/4 inch scaled fabrication and layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that the area materials and rigidity are not reduced.
2. Submit diffuser, register, and grille performance characteristics including, CFM ratings, pressure drops, NC levels, and throw patterns.
3. Submit louver color samples for selection and approval.
4. Submit duct access door coordination drawing for approval.

1.3 QUALITY ASSURANCE

A. SMACNA Standards:
1. Comply with SMACNA's "HVAC Duct Construction Standards, second edition".
2. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual".

B. ASHRAE Standards: Comply with ASHRAE Systems and Equipment Handbook.

C. NFPA Compliance: Comply with NFPA 90A "Standard for the installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems".

D. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.

E. Air terminals shall comply with ARI 880, "Industry Standard for Air Terminals" and shall bear the ARI certification seal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Flexible Duct:
   a. Flex-Master
   b. Thermaflex
   c. Hercules
2. Balance Dampers:
   a. Greenheck

b. Ruskin
c. Pottorff

3. Fire Dampers and Combination Fire/Smoke Dampers:
   a. Greenheck
   b. Ruskin
   c. Pottorff
4. Ductwork:
   a. Hercules
   b. Shop fabricated.
5. Filters:
   a. American Air Filter
   b. Farr
   c. Koch
6. Air Terminal Units:
   a. Price
   b. Environmental Technologies/JCI
   c. Titus
   d. Nailor
7. Grilles, Registers and Diffusers:
   a. Metalaire
   b. Titus
   c. Price
   d. Nailor
8. Louvers:
   a. Greenheck
   b. American Warming/Air Balance
   c. Ruskin

2.2 MATERIALS, GENERAL

A. Ductwork:
   1. Galvanized Ducts: Lock-forming quality, ASTM A527, Coating designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view. Provide flat seam construction where standing seams are a hazard to the university operating personnel.
   2. Aluminum Ducts: ANSI/ASTM B209; aluminum sheet, alloy 3003, Temper H14. Aluminum connectors and bar stock shall be Alloy 6061-T6 or equivalent strength.
   3. Stainless Steel Ducts: ASTM A480 Type 316 with No. 4 finish on surfaces of ducts exposed to view; Type 304 with No. 1 finish for concealed ducts. Protect finished surfaces with mill applied adhesive protective paper, maintained through fabrication and installation.
   4. Sealant: UL listed, Class 1, flame spread 0, fuel contributed 0, smoke developed 0, water based sealer.
   5. Flexible Duct Fan Connections: Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards. UL 181 fire-resistant, neoprene coated, woven glass fiber fabric, minimum 30 oz. per square yard, crimped into metal edging strip. Suitable for 1-1/2 times duct pressure at connection. Outside flexible duct connectors shall be rated for outdoor use.
   6. Flexible Duct: Comply with UL 181, Class 1.
      a. Uninsulated: Spiral-wound galvanized steel helix, mechanically locked to fiber glass cloth fabric.
      b. Insulated: Inner core of one ply corrugated aluminum duct, 1-inch thick, ¾ pound insulation and aluminized vapor barrier.
   7. Accessories:
      a. Turning Vanes: Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades and mounting straps.
      b. Duct Access Doors:
         1) Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards and as indicated.

2) Fabricate rigid and close fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
3) Access doors smaller than twelve inches square may be secured with sash locks.
4) Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
5) Access doors with sheet metal screw fasteners are not acceptable.

B. Dampers:
1. Backdraft Dampers: Parallel blades, gravity balanced backdraft dampers shall be made of 16 gauge galvanized steel. Provide center pivoted blades of maximum six inch width, with flexible vinyl sealed edges, linked together in a rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin, and adjustment device to permit setting for varying differential static pressure.
2. Low Pressure Manual Dampers: Single or multi-blade type with position-indicating device and lock.
3. Fire Dampers: Fabricated in accordance with NFPA 90A and UL555. Fabricate curtain type dampers of galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for low pressure ducts up to 12 inches in height. Fabricate multiple blade fire dampers with 16 gauge galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 X 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops and lock. Fusible links, UL 33, shall separate at 160 degrees F. Provide adjustable link straps for combination fire/balancing dampers
4. Combination Fire Smoke Dampers: Fabricated in accordance with NFPA 90A, 92A, 92B, and UL Standards 555 and 555S. Dampers shall have a UL555 fire rating of
5. Each damper shall be equipped with a heat responsive device which has been tested and approved for use with the damper assembly in accordance with UL555. The heat responsive device shall have a temperature rating of 165 F or 212 F. Dampers shall be UL labeled for use in dynamic systems. The damper shall have a dynamic closure airflow rating equal to or greater than the airflow at the damper's installed location and a dynamic closure pressure rating of 4 in wg.
    a. Dampers shall have a UL555S Leakage rating of Class II and a Temperature rating of 350 F. Dampers shall have a UL555S operational airflow rating equal to or greater than the airflow at its installed location and an operational pressure rating of 4 in wg. Damper actuators shall be factory mounted and qualified for use with the damper in accordance with UL555S. Damper actuators shall be electric type for 120, 24 volt operation or pneumatic type for 20 PSI minimum operation.
    b. The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3 and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D.
    c. Damper blades shall be 16 ga galvanized steel 3 Vee type with three longitudinal grooves for reinforcement. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper (blades that are non-symmetrical relative to their axle pivot point or utilize blade stops larger than 0.5 in are unacceptable).
    d. Damper frames shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearings shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Jamb seals shall be stainless steel compression type.

6. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.

C. Filters:
1. Disposable Pre-filters (MERV 8):

a. Media: 4 inch thick, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive. 20 gauge galvanized steel holding frame. Nominal size 24 inches by 24 inches. Pre-filters shall have slide-in frames, which shall be sealed to prevent bypass.
b. Rating: 500 FPM face velocity, 0.15 inches w.g. initial resistance, 0.5 inches w.g. final resistance.

2. Extended Surface Retained Media Filters (MERV 11):
   a. Media: Pleated, non-woven cotton fabric, scrim reinforced. 16 gauge galvanized steel holding frame with corrosion resistant coating. Effective media area of 50 square feet per 1000 CFM. Nominal size 24 inches by 24 inches by 12 inches deep.
   b. Rating: ASHRAE 52; 60 percent dust spot efficiency, 96 percent average weight arrestance. 500 FPM face velocity, 0.5 inches w.g. initial resistance, 1.2 inches w.g. final resistance.
3. Extended Surface High Efficiency Media Filters (MERV 14):
   a. Media: Pleated, water resistant glass fiber with aluminum or kraft separators. 16 gauge galvanized steel holding frame with corrosion resistant coating. Effective media area of 50 square feet per 1000 CFM. Nominal size 24 inches by 24 inches by 12 inches deep.
   b. Rating: ASHRAE 52; 95 percent dust spot efficiency. 500 FPM face velocity, 0.65 inches w.g. initial resistance, 1.0 inches w.g. final resistance.
4. High Efficiency Particulate (HEPA) Filters (MERV 17+):
   a. Media: Pleated, water-resistant glass fiber with aluminum separators; ANSI/UL 586. 16 gauge galvanized steel holding frame with corrosion resistant coating. Nominal size 24 inches by 24 inches by 12 inches deep.
   b. Rating: 0.3 micron DOP to 99.97 percent efficiency in accordance with MI-STD-282 thermal DOP penetration test method. 250 FPM face velocity, 1.0 inches w.g. initial resistance, 3.0 inches w.g. final resistance.
5. Activated Carbon Filters:
   a. Assembly: Galvanized steel unit with extruded aluminum tracks to accommodate filter servicing trays in deep V arrangement for upstream/downstream side servicing with disposable panel pre-filter.
   b. Media: Activated carbon density 34 lb./cu ft pelletized or granular to 6 by 10 Tyler mesh screen. Minimum carbon tetrachloride activity of 60 percent. Nominal size 24 inches by 24 inches by 1 inch thick. 9 pounds of carbon per 2000 CRM air flow.
   c. Rating: 500 FPM face velocity, 0.45 inches w.g. initial resistance.

D. Air Terminals:
1. General: Air terminals shall not exceed sound ratings as scheduled in accordance with AMCA 301 and tested according to AMCA 300.
2. Single-Duct Variable Air Volume:
   a. Casing: Minimum 22 gauge galvanized steel with volume damper assembly inside. Access panel in bottom of unit for access to air valve/damper.
   b. Insulation: Minimum 1-inch, 1.5 pound density fiberglass, neoprene or vinyl coated insulation complying with NFPA 90A and UL 181. Exposed edges of insulation coated with NFPA 90A approved sealant.
   c. Air Valve/Damper: Extruded or cast aluminum, automatic pressure compensating. Air valve/damper to seal 100% shut off. Maximum leakage not to exceed 2 % of rated airflow at 3 inches inlet static pressure. Valve/Damper to be (normally open)(normally closed). Capable of operating with pressure drop across the unit as low as 0.4 inch w.g.
   d. Airflow Sensor: Multi-point, averaging type.
   e. Heating Coil:Copper tube mechanically bonded to aluminum fins. Leak tested underwater to 200 psig.
   f. Controls: Devices compatible with temperature controls specified in Section 23 09 00.

E. Air Inlets and Outlets:
1. Louvers:
   a. Test and rate performance in accordance with AMCA 500.

b. Stationary Steel Louver: 16 gauge galvanized steel louver with 4-inch storm proof and drainable blades on 4-inch centers at 45 degree angle and channel mounted in extruded aluminum rewireable frame. frame construction with storm proof blades. Provide aluminum bird screen.
c. Stationary Aluminum Louver: Extruded aluminum, 0.081 inch thick louver with 4-inch storm type blades with 5-inch spacing at 45 degree angle with storm proof and drainable blades. Head, sills, and jambs to be one piece extruded structural members. Fastenings shall be either stainless steel or aluminum. Fixed blade accurately fitted and firmly secured to frames. Provide aluminum bird screen mounted in extruded aluminum rewireable frame.

F. Grilles, Registers, and Diffusers:
1. General:
a. Test and rate performance in accordance with ARI 880 and ASHRAE 70.
b. Coordinate borders and mounting frames with ceiling and wall finish.
c. Provide airflow capacity and throw patterns as shown. Pressure drops of diffusers and supply registers shall not exceed 0.1 inch w.g. and pressure drops for return and exhaust grilles shall not exceed 0.05 inch w.g. unless otherwise shown.
d. Dampers shall be opposed blade type; key or standard blade screwdriver operated from the face of the unit.
e. Provide opposed blade damper keys.
2. Diffusers:
a. Louvered Face: Square, louvered face steel diffuser with movable blades accessible from face for adjustable discharge and volume damper. Border style compatible with ceiling system. Finish shall be white. Face size shall equal ceiling module size when mounted in ceiling grid; i.e., a diffuser with 24-inch x 24-inch face would be provided for a 24 x 48 ceiling grid.
b. Linear bar diffuser with deflection bars fixed and parallel to long dimension with opposed blade damper. Finish shall be white. Provide alignment strips to join sections together end-to-end for continuous appearance.
c. Slot: Aluminum linear slot diffuser with direction and volume adjustable by 180 degree controller. Number of slots shall be as shown. Finish shall be white. Diffuser shall be capable of being joined end-to-end for continuous appearance. Provide steel blankoffs, alignment pins, end caps, and borders.
d. Round: Round diffuser constructed of 18 gauge steel with four round cones and round inlet neck. Field adjustable airflow discharge pattern from horizontal to vertical. Finish shall be white. Provide with round steel damper and safety chain.
3. Registers:
a. Supply Register: Double deflection, 3/4-inch blade spacing, 1-1/4-inch steel border with extruded aluminum airfoil blades and steel opposed blade damper. Front blades parallel to long dimension. Blades individually adjustable and securely held in place. Provide gasket between the frame and surface. Register finish shall be white.
4. Grilles:
a. Perforated steel ceiling grille with 3/16-inch diameter holes on 1/4-inch staggered centers. Finish shall be white.
b. Wall Grilles: 45-degree deflection, 3/4-inch blade spacing, steel grille with front blades parallel to long dimension. Grille finish shall be white.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

A. Accessories
1. Install access doors of sufficient size at all fire damper, filter, or coil location to provide for cleaning and inspection.
2. Where fire dampers are installed, paint duct red at damper.

3. Provide tight fitting access doors sealed with gaskets for inspection and replacement of fusible links. Doors shall be installed, so access is unobstructed. Where these doors occur on concealed ducts, provide access doors in walls or ceiling properly aligned to permit the servicing of the fusible links. Mark ceiling or walls according to accepted identification.

B. Ductwork:
1. Maximum flexible ductwork length shall be 6 feet. Secure flexible ductwork to collars with metal bands. Support at least every 3 feet.
2. General: Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type that will hold ducts true to shape and to prevent buckling, popping or compressing. Support vertical ducts at every floor.
3. Construct ductwork to schedule of operating pressures as shown on drawings.
4. Inserts: Install concrete inserts for support of ductwork in coordination with form work, as required to avoid delays in work.
5. Field Fabrication: Complete fabrication of work at project as necessary to match shop fabricated work and accommodate installation requirements.
6. Routing: Run ductwork in shortest route that does not obstruct useable space or lock access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of the building. Limit clearance to 1/2 inch where during is shown for enclosure or concealment of ducts, but allow for insulation thickness. Locate insulated ductwork for 1 inch clearance outside of insulation. In finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings, Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
7. Electrical Equipment Spaces: Do not route ductwork through transformer vaults and their electrical equipment spaces and enclosures.
8. Transitions: Diverging transitions shall not exceed 15 degrees per side. Converging transitions shall not exceed 30 degrees per side.
9. Elbows: Use radius elbows with throat radius equal to duct depth wherever possible.
10. Flexible Duct Fan Connections: Install flexible duct with at least one inch slack to insure that no vibration is transmitted from fan to ductwork.
11. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as the duct. Overlap opening on all four sides by at least 1-1/2 inch. Fasten to duct only.
12. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment controls and other associated work of ductwork system.
13. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at the time of the ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

C. Sealing of Ducts:
1. General:
    a. All ducts, seams, and joints (lateral and horizontal) shall be sealed with sealant.
    b. Metal surfaces to be joined shall be clean, dry, and grease free.
    c. Apply a heavy brush coat of sealant to the interior metal surface of the duct slip joint, then interlock securely the duct sections and position into place.
    d. Apply a heavy brush coat finish of sealant to the exterior metal surface duct joint or seam covering heads of lock joint screws. Ensure that all voids are completely filled to provide a continuous air pressure seal.
    e. Where ducts are subject to excessive vibration or mechanical abuse, the exterior joint finish shall consist of a heavy coat of brush applied sealant reinforced with 2-inch wide glass fabric. Press the reinforcing fabric into the wet sealant and cover with a second coat of brush applied sealant.

2. Low pressure ducts: Seal in accordance with SMACNA standards for Class B seals.
3. Medium and high pressure ducts: Seal in accordance with SMACNA standards for Class A seals.

D. Fire and Smoke Dampers:
1. Install dampers with code approved sleeves.
2. Install in accordance with UL requirements. Provide access door in duct.

E. Grilles, Registers, and Diffuser Installation:
1. In moist areas, install grilles, registers, and diffuser with stainless steel or aluminum fasteners.
2. When installing grilles, registers, and diffusers in existing drop ceilings provide additional T-sections as required for a finished opening for the grille, register, or diffuser.
3. All grilles and diffusers mounted in hard ceiling, must be set in frame and be removable to limit the use of access doors

F. Air Pressure Gauges:
1. Provide magnehelic gauges at all air handling unit filter housings.
2. Provide an engraved nameplate on each magnehelic gauge indicating the normal operating pressure.

G. Access Panels:
1. Install access panels for inspection, maintenance, and cleaning of all automatic dampers, fire and smoke dampers, duct turning vanes, before and after all coils, and at other locations where equipment will require service.
2. Access panels to fire dampers shall be labeled with letters not less than 1/2-inch in height reading "Fire Damper." For locations where access panels are insulated, provide identifying labels on the exterior of the insulation.

H. Filters:
1. Install bag-in/bag-out filters at location shown on drawings. Housing shall be labeled "Danger, Hazardous Material". Install housing in accordance with manufacturer’s instructions and allow a minimum 36" clearance for access.

3.2 TESTING, CLEANING, AND CERTIFICATION

A. Air Cleaning Devices: Systems shall not be operated during construction.

B. Leakage Tests: Conduct duct leakage test in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than the maximum permissible leakage as specified below.

C. General:
1. Ductwork pressure tests shall be observed by Architect/Engineer prior to installation of insulation.
2. Ductwork systems in the three-inch W.G. pressure class and higher shall be tested in their entirety for leaks. Arbitrary sections of ductwork in the two inch W.G. and lower pressure class shall be tested as required by the Engineer.
3. Test Failures: Duct systems shall be repaired if test pressure and leakage requirements are not met or if air noise condition is encountered. Repairs and sealing shall be done with sheet metal, tape, sealant, or a combination thereof.

D. Fire and Smoke Damper:
1. Dampers shall be tested and accepted in accordance with NFPA prior to project closeout.

E. All tests shall be witnessed by the university’s representative and approved by Architect/Engineer and the university representative, coordinated through the Project Manager.

END OF SECTION 23 30 00

SECTION 23 40 00 - HVAC FANS

PART 1 - GENERAL

1.1 DESIGN REQUIREMENTS

A. Exhaust Systems:
1. Exhaust systems that may transport offensive odors, noxious gases, etc., are to be separate systems. Provide identifying labels on exterior stacks per the instructions of the Project Manager.
2. Locate fans so that negative pressure exists in all exhaust ducts within buildings.
3. Conditioned make-up air shall be provided to compensate for exhaust.
4. Recirculation systems are not allowed in laboratory spaces.
5. Refer to Section 23 00 00 for Special HVAC Systems including lab exhaust systems.
6. Lab exhaust systems to utilize utility set fans, with exhaust stacks. Design of exhaust stack to be justified per AHRAE design requirements, or via a wind/wake analysis. Use of high-plume dispersion type fans are at the approval of the university project manager.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Fans:
   a. Acme
   b. New York Blower
   c. Greenheck
   d. MK Plastics – Reference 1.1
   e. Cook
   f. Twin Cities

2.2 MATERIALS, GENERAL

A. Centrifugal Fans:
1. Unit Casing: Galvanized steel panels, formed and reinforced, seams continuously welded. All interior and exterior surface steel shall be coated with a minimum of 2-4 mils of Polyester Urethane, electrostatically applied and baked. No uncoated metal fan parts will be allowed. Provide access doors or panels to allow access to internal parts and components.
2. Fan Wheel: Non-overloading single width airfoil centrifugal type. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19. Fan wheel shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of Polyester Urethane, electrostatically applied and baked
3. Shaft: Turned, ground, polished, and rust protected steel. Designed to operate at no more than 70 percent of the first critical speed at the top of the fan’s speed range.
4. Shaft Bearings: Air handling quality self-aligning, heavy duty, pillow block type, roller or ball type bearings with L.10 rated bearing life of 80,000 operating hours. Provide extended lube lines.
5. Belt Drives: V-belt drives rated at not less than 200% of motor nameplate rating. Belt speeds shall not exceed 4500 feet per minute. Center distances between driver and driven sheaves must meet the manufacturer's minimum and maximum. Belts shall be notched AX, BX or CX series.
6. Sheaves: All sheaves shall be fixed pitch type. Variable pitch sheaves are not permitted. Fixed pitched sheaves supplied with units shall be replaceable by fixed pitched sheaves for balancing purposes. No sheave shall be less than 3.9 inch PD
7. All accessible inlet or exhaust openings in fans shall have 1/2 inch square wire mesh guards covering those openings as well as belt and pulley guards.
8. Motor nameplate to include stamped bearing size.

9. All large motors will have double pull, adjustable motor mounts.
10. Size fans to provide design airflow at 15% below maximum rpm as suggested by the manufacturer.
11. Motors: Reference 23 05 13 Motors for more information.
12. Belt Guard: Fabricated to OSHA and SMACNA requirements.
13. Accessories:
    a. Scroll access doors shaped to conform to scroll with quick-opening latches and gaskets.
    b. Galvanized steel companion flanges for duct connections.
    c. 2-inch drain connections.
    d. Removable inlet and outlet safety screens for access to fan for maintenance.

B. Propeller Fans
1. Panel: Painted steel fan panel with welded corners, pre-punched mounting holes, deeply spun venturi, integral stiffening flanges, and motor support.
2. Motor: Permanently lubricated, continuous duty type. Reference 23 05 13 Motors for more information.
3. Fan Shaft: Ground, polished, and coated steel.
4. Drive Type:
    a. Belt drive:
        1) Motor Pulleys: Fixed pitch, cast iron, sized for 150 percent of maximum cataloged speed.
        2) Bearings: Heavy duty ball bearings with L10 rated bearing life exceeding 200,000 operating hours.
5. Fan Blades: Statically and dynamically balanced steel or aluminum blades.
6. Accessories:
    a. Rear Fan Guard: Removable or with removable access section for fan maintenance, conforming to OSHA requirements.
    b. Wall Shutter:
        1) Gravity shutter with heavy aluminum frame, blades interconnected with tie-rods, and nylon bearings.
        2) Motorized shutter with heavy aluminum frame, blades interconnected with tie-rods, nylon bearings, and actuator motor to power open and spring return.
    c. Wall Sleeve: Galvanized steel sleeve with moveable angle frame.

C. Roof and Wall Ventilators:
1. Housing: Weatherproof, heavy-gauge spun aluminum with rigid steel internal support structure.
2. Fan Wheel: Aluminum, non-overloading, backward inclined, centrifugal type. Dynamically balanced.
3. Motor: Open drip proof, high-efficiency motor, mounted out of the air stream. Reference 23 05 13 Motors for more information.
4. Shafts: Solid steel, precision ground, polished, and treated for rust resistance.
5. Drive:
    a. Belt drive:
        1) Bearings: Heavy duty, with L-10 rated bearing-life exceeding 80,000 operating hours.

2.3 QUALITY ASSURANCE

A. Codes, Regulations and Standards: Comply with the following:

B. Propeller Fans
1. Panel: Painted steel fan panel with welded corners, pre-punched mounting holes, deeply spun venturi, integral stiffening flanges, and motor support.
2. Motor: Permanently lubricated, continuous duty type.
3. Fan Shaft: Ground, polished, and coated steel.
4. Drive Type:

a. Belt drive:
1) Motor Pulleys: Fixed pitch, cast iron, sized for 150 percent of maximum cataloged speed.
2) Bearings: Heavy duty ball bearings with L10 rated bearing life exceeding 80,000 operating hours.

5. Fan Blades: Statically and dynamically balanced steel or aluminum blades.
6. Accessories:
a. Rear Fan Guard: Removable or with removable access section for fan maintenance, conforming to OSHA requirements.
b. Wall Shutter:
1) Gravity shutter with heavy aluminum frame, blades interconnected with tie-rods, and nylon bearings.
2) Motorized shutter with heavy aluminum frame, blades interconnected with tie-rods, nylon bearings, and actuator motor to power open and spring return.
c. Wall Sleeve: Galvanized steel sleeve with moveable angle frame.
7. Motors: Reference 23 05 13 Motors for more information.

C. Roof and Wall Ventilators:
1. Housing: Weatherproof, heavy-gauge spun aluminum with rigid steel internal support structure.
2. Fan Wheel: Aluminum, non-overloading, backward inclined, centrifugal type. Dynamically balanced.
3. Motor: Open drip proof, high-efficiency motor, mounted out of the air stream. Reference 23 05 13 Motors for more information.
4. Shafts: Solid steel, precision ground, polished, and treated for rust resistance.
5. Drive:
a. Belt drive:
1) Bearings: Heavy duty, with L-10 rated bearing-life exceeding 200,000 operating hours.
2) Pulleys: Cast iron fixed pitch, sized for 150 percent of the driven horsepower.
6. Vibration Isolators: Multidirectional, rubber-in-shear.
7. Screen: Aluminum bird screen.
8. Roof Curb:
a. Field-built.
b. Prefabricated, galvanized curb with welded seams and fastening flange for “self-flashing”. Closed cell neoprene rubber gasketing around the top of the curb and 1-1/2-inch thick, 3-pound density rigid insulation along the sides. Curbs shall be minimum 14” high.
9. Nameplate: Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
10. Accessories:
a. Hinged Sub-base: Rust-proof hinge arrangement permits access to curb well for access to curb mounted dampers.
b. Backdraft damper: Galvanized steel frame, multi-leaf, roll formed aluminum blades with nylon bearings.

D. Upblast Roof Ventilators:
1. Housing: Heavy-gauge spun aluminum housing with rigid steel internal support structure, spun aluminum windband, and aluminum base with continuously welded curb cap corners.
2. Fan Wheel: Aluminum, non-overloading, backward inclined, centrifugal type. Dynamically balanced.
3. Motor: Heavy duty type, permanently lubricated, sealed ball bearing, open drip proof, high-efficiency motor, mounted out of the air stream. Reference 23 05 13 Motors for more information.
4. Shafts: Solid steel, turned, ground, and polished.
5. Drive:
a. Belt drive, cast iron, keyed and securely attached to wheel and motor shafts:
1) Bearings: Heavy duty, greasable ball type mounted in cast iron housing, L10 rated 100,000 operating hours.

2) Pulleys: Fixed pitch, sized for 150 percent of the driven horsepower.

6. Vibration Isolators: Multidirectional, rubber-in-shear.
7. Screen: Aluminum bird screen.
8. Roof Curb:
   a. Field-built.
   b. Prefabricated, galvanized curb with welded seams and fastening flange for "self-flashing". Closed cell neoprene rubber gasketing around the top of the curb and 1-1/2-inch thick, 3 pound-density rigid insulation along the sides.
9. Accessories:
   a. Hinged Sub-base: Rust-proof hinge arrangement permits access to curb well for access to curb mounted dampers.
   b. Backdraft damper: Galvanized steel frame, multi-leaf, roll formed aluminum blades with nylon bearings. Motorized Actuator.
   c. Provide fans with UL-762 listing for all grease applications.

E. Ceiling Fan:
1. Housing: Acoustically insulated, galvanized steel housing with chatter proof damper.
2. Fan Wheel: Centrifugal type, dynamically balanced.
3. Motor: Permanently lubricated, direct drive motor with built-in overload protection and plug in disconnects. Motor mounted on rubber mountings. Reference 23 05 13 Motors for more information.

F. Utility Set Fans:
1. General: Fan constructed such that all surfaces are heavy coated high performance epoxy powder coating Green Kote TM plus or equal, rated at 250°F, 3-4 mils thick. All nuts, bolts and fasteners shall be type 316 SST and powder coated. No un-coated surfaces will be acceptable.
2. Performance: Fan ratings shall be based on tests made in accordance with AMCA Standard 210 and licensed to bear the AMCA Certified Ratings Seal for Air Performance. Fans shall have a sharply rising pressure characteristic extending throughout the operating range to assure quiet and stable operation. Fan brake horsepower shall be equal to or less than the BHP specified in the schedule at the listed static pressure and CFM.
3. Sound: Fan manufacturers shall provide sound power level ratings for fans tested and rated in accordance with AMCA Standards 300 and 301.
4. Bearings: Bearings are to be grease lubricated, precision anti-friction ball, self-aligning, pillow block design. Bearings shall be designed for a minimum L-10 life of 200,000 hours when rated at the fan's maximum cataloged operating speed. Fan bearings shall be visible and accessible for inspection, maintenance, and replacement. Bearings enclosed within the fan housing where they can be exposed to the corrosive gas steam are not acceptable.
5. Construction: Fan constructed in accordance with the ASTM D-4167 standard for fiber-reinforced plastic fans and blowers to ensure structural integrity. Fans shall be suitable for outdoor use.
6. Housing: Constructed with fire retardant vinyl ester resin with an ASTM E84. Housing laminate construction shall conform to ASTM Standard C-582. Shaft hole openings fitted with a teflon closure having a maximum clearance of 1/32 inch to minimize leakage. Inlet assembly bolted to permit wheel removal. Housing shall have weep holes to allow moisture to drain.
7. Wheel: Backward inclined, non-overloading design for increased efficiency. Wheel coated with a fire-retardant vinyl ester resin with an ASTM E84 flame spread of 25 or less. Wheel hub permanently bonded to the shaft and completely encapsulated in FRP to insure corrosion resistant integrity.
8. Shaft: Solid, ASTM A-108 steel, grade 1040/1045 with an FRP sleeve fixed securely and bonded to the wheel backplate. The sleeve shall extend out through the housing shaft hole for corrosion protection. Shaft shall be countersunk for tachometer readings.
9. Fan shaft and bearings to be eccentric lock or taper lock to prevent fretting. Set screws for bearing locks are not allowed.
10. Balance and Run test: The wheel and shaft shall be dynamically balanced, as an assembly, in accordance with ASTM D-4167 and ANSI S2.19-1975, Grade 6.3. Prior to shipment, completed fans shall receive a final test-balance at the specified operating speed.

11. Accessories:
    a. Weather Cover/Belt Guard.
    b. V-Belt Drive, Adjustable. Provide multi-belt type drive.
12. Provide spring-operated automatic lubricator. Provide LubeSite 560 with 6 oz reservoir. Each lubricator shall be suitable for outdoor use, corrosion resistant, suitable for operation from –20 to 120º F, with Viton piston seal ring, and fully compatible with fans and lithium-based lubricant. Other acceptable manufacturers: Alemite, or SKF.

END OF SECTION 23 40 00

SECTION 23 52 00 - HEAT BOILERS

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Boilers included in this Section are intended for structures constructed outside the practical limits of the campus central steam distribution system and have access to natural gas.

B. Design these systems as simple heating water hydronic systems to meet building heating and ventilating requirements.

1.2 QUALITY ASSURANCE

A. Electrical components shall comply with NFPA 70-96 and be UL listed.

B. Boilers shall comply with ASME Boiler and Pressure Vessel Code, Section IV-95.

C. Boilers tested and rated according to the Hydronics Institute's "Testing and Rating Standard for Heating Boilers" with I=B=R emblem on a nameplate.

1.3 WARRANTY

A. Boilers warranties shall be provided in accordance with Section 23 00 00, including the manufacturer's standard warranty of not less than 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Inclined Water Tube Boiler:
      a. Anax
      b. Rite
   2. Cast-Iron Boilers:
      a. Burnham
      b. Peerless
      c. Weil-McLain
   3. High-Efficiency Compact Boiler:
      a. Lochnnar
      b. Patterson-Kelly
   4. Scotch Marine Boiler:
      a. Burnham
      b. Kewaner
      c. Superior
   5. Condensing Boiler:
      a. AERCO
      b. Buderus
      c. Viessman

2.2 MATERIALS, GENERAL

A. Inclined Water Tube Boiler:

1. Type: Factory assembled, packaged, and tested forced draft inclined water tube boiler. Non-condensing design to operate at 80 percent efficiency.
2. Construction:
   a. Free-floating tube bundle assembly consisting of steel tubes, 2-inch diameter supported by steel fame with expansion joint at each corner.
   b. Tubes sloped upward from rear to front to eliminate air bubbles.
   c. Full-face reinforced neoprene head gasket.
   d. 18 gauge galvanized or painted steel jacket.
3. Pressure Rating: 125 psi working pressure, ASME stamped.
4. Burner:
   a. UL listed forced draft burner for operation with pressurized vent stack without barometric damper or induced draft fan.
   b. Fuel: Natural gas.
   c. Electronic supervised spark ignition.
   d. Burner Safety Controls:
      1) Scanner or ultraviolet flame detector.
      2) Airflow switch.
   e. Positive pressure at flue collar.
5. Boiler Controls and Trim:
   a. Operating control.
   b. High limit control
   c. Low water cutoff.
   d. ASME pressure relief valve set at proper psi for operating conditions.
   e. Combination temperature/pressure gauge.
   f. Built-in air elimination.
   g. Control panel with indicating lights.
6. Gas Train:
   a. UL and FM listed gas train, factory assembled.
   b. Main gas pressure regulator.
   c. Main gas valve.
   d. Main and pilot gas shut-off valves.
   e. Auxiliary gas valve.
   f. Dual safety gas valves.
   g. Low and high gas pressure gas switches above 2500 MBH.

B. Cast-Iron Boilers:
1. Factory assembled and packaged, with cast-iron sections set on an insulated steel base, sealed with high-temperature sealant, held together with tie rods, and with insulated extended jacket and vent connection.
2. Gas Burner:
   a. Atmospheric or forced draft type.
   b. Modulation firing.
   c. Prepurge.
   d. Low fire start.
   e. Modulating position air control.
   f. Pressure regulator.
   g. Gas valves, manual shutoff, intermittent spark or glow coil ignition, flame-sensing device, and automatic 100 percent shutoff.
3. Pressure Rating: 30 psig.
4. Fuel: Natural gas.
5. Trim and Accessories:
   a. Safety Relief Valve: ASME rated, factory set at boiler pressure rating.
   b. Gauge: Combination water pressure and temperature. Pressure range to be 0 - 50 psig and temperature range to be 40 to 240 degrees F.
   c. Low Water Cutoff: Prevent burner operation on low water level.

d. High Limits: Two temperature controls to limit boiler water temperature. One with automatic reset, the other with manual reset.
e. Operating Controls: Prewired, factory assembled electric control including pilot safety and thermocouple transformer, 24-volt gas valve, manual main and pilot valves.
f. High pressure gas switches
g. Electronic pilot ignition.
h. Safety pilot switches: 100% shut-off.
i. Gas pressure regulator.
j. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, and stop gas flow on ignition failure.

C. High-Efficiency Compact Boiler:
1. Radial fired, vertical hot water boiler with gas fired power burner. Non-condensing design to operate at AGA certified efficiency of 85 percent.
2. Construction:
a. Combustion Chamber: 16 gauge corrosion resistant aluminized steel or cast iron.
b. Heating Surface: Finned copper tubes.
c. Outer Cabinet: Minimum 16 gauge steel, air tight, with an insulating air space between the combustion chamber and outer cabinet.
d. Cabinet Finish: Baked epoxy coating finished inside and out.
e. Factory assembled and fire tested.
3. Pressure Rating: 160 psi working pressure.
4. Burner:
a. Gas power burner, radial fired.
b. Fuel-air mixture controlled by multiple brass orifices and venturi core equipped to measure air flow rate to the burner.
5. Burner Controls:
a. Electric spark ignition with interrupted type pilot.
b. Flame rod pilot and main flame control.
c. AGA approved electronic flame safeguard programmer with pilot failure and lock-out with manual reset.
6. Gas Manifold:
a. AGA lubricated plug cock.
b. Pressure regulator.
c. Low gas pressure switch.
d. Two solenoid-operated diaphragm valves.
e. Pilot gas manifold with cock, pressure regulator, gas filter and solenoid valve.
f. Both gas manifolds, main and pilot, to be accessible without removing cabinet.
7. Smoke Venting:
a. Boiler AGA certified as “Category 1” for venting, requiring either a double wall or an insulated type “B” vent pipe.
8. Trim and Accessories:
a. Safety Relief Valve: ASME rated, factory set at boiler pressure rating.
b. Gauge: Combination water pressure and temperature. Pressure range to be 0 to 50 psig and temperature range to be 40 to 240 degrees F.
c. Low Water Cutoff: Prevent burner operation on low water level.
d. High Limits: Two temperature controls to limit boiler water temperature. One with automatic reset, the other with manual reset.
9. Fuel: Natural gas.

D. Scotch Marine:
1. Multi-pass, horizontal fire-tube boiler factory-mounted on heavy steel base frame. Boiler to provide 80 percent efficiency.
2. Construction:
a. Insulated metal jacket.
b. Insulated front flue doors.

c. Refractory filled rear access with observation port.
d. Bottom blowdown connection.
e. Heating Surface: 5 square feet of heating surface per rated BHP.
f. Cabinet Finish: Baked epoxy coating finished inside and out.
g. Factory assembled and fire tested.

3. Burner:
   a. UL/FM approved forced-draft burner, rated to produce full output at 5200-foot elevation.
   b. Radial port flame retention type burner head and diffusers.
4. Burner Controls:
   a. Direct spark ignition electrode.
   b. Ultraviolet flame detector.
   c. Airflow safety switch.
   d. Modulating control motor with linkage to control modulating gas valve and air inlet damper for proper fuel air mixtures.
5. Gas Train:
   a. AGA lubricated plug cock.
   b. Gas regulator.
   c. Motorized gas valve with proof of closure switch.
   d. Safety gas valve.
   e. Pressure regulator.
   f. High and low gas pressure switch.
   g. Pilot solenoid valve.
   h. Pilot gas manifold with cock, and pressure regulator.
   i. Both gas manifolds, main and pilot, to be accessible without removing cabinet.
6. Smoke Venting:
   a. Boiler AGA certified as “Category 1” for venting, requiring either a double wall or an insulated type “B” vent pipe.
   b. Type B Gas Vent: Double wall gas vent complying with NFPA 211-96, inner pipe of sheet aluminum, outer pipe of galvanized steel sheet. Provide tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, fire-stop spacers, and fasteners.
7. Trim and Accessories:
   a. Safety Relief Valve: ASME rated, factory set at boiler pressure rating.
   b. Gauge: Combination water pressure and temperature. Pressure range to be 0 to 50-psig and temperature range to be 40 to 240 degrees F.
   c. Low Water Cutoff: Prevent burner operation on low water level.
   d. High Limits: Two temperature controls to limit boiler water temperature. One with automatic reset, the other with manual reset.
8. Fuel: Natural gas.

E. Condensing Boiler:
1. Boilers shall be natural gas fired, condensing fire-tube design with a modulating forced draft power burner and positive pressure vent discharge.
   a. Modulating Air/Fuel Valve and Burner
   b. The boiler burner shall be capable of a 10 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves.
   c. The burner shall produce <30 ppm of NOx corrected to 3% excess oxygen.
   d. All burner material exposed to the combustion zone shall be of stainless steel construction. Dual heat exchangers utilizing stainless steel or aluminum alloy in only one of the heat exchangers are not permitted.
   e. A variable speed cast aluminum pre-mix blower shall be utilized to ensure the optimum mixing of air & fuel between the air/fuel valve and the burner.
2. Pressure Vessel/Heat Exchanger
   a. Boiler shall be capable of handling return water temperatures down to 40 F without any failure or corrosion for the life of the boiler.

b. Heat exchangers shall be constructed of 316L stainless steel fire tubes and tube sheets with a one-pass combustion gas flow design. The fire tubes shall be 5/8" OD with no less than 0.065" wall thickness. Upper and lower stainless steel tube sheets shall be no less than 0.313" thick. Access to the tube sheets and heat exchangers are available by burner and exhaust manifold removal.

3. Exhaust Manifold
   a. Provide materials and routing per manufacturer and code requirements. Provide drain in flue vent where recommended by manufacturer.
4. Controls:
   a. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant.
   b. The system shall control the boiler outlet header temperature within +2ºF. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The system controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.
   c. Acid neutralization: Provide acid neutralizers as needed.

F. Controls:
1. UL listed, electronic boiler control with adjustable reset ratios, adjustable offset to raise or lower reset curve, adjustable outdoor cutoff, night set back, minimum boiler water temperature adjustment, setback clock and adjustable morning warm up, manual override, LED indication of Setback, Bypass and On.
2. Provide standalone controls by manufacturer. Controllers shall have software interface with BAS to reset temperatures and schedules. Provide communication gateway if required

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install boilers level and plumb, according to manufacturer's recommendations.

B. Install boilers on 4-inch thick concrete base, 4 inches larger on each side than base of unit.

C. Install natural gas-fired boilers according to NFPA 54-96. Connect gas piping full size to boiler gas train inlet. Install with a union and dirt leg.

D. Connect heating water piping to boiler with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valve to nearest floor drain.

F. Controls:
1. Wire boiler burner so it cannot fire unless heating water-circulating pump is running.
2. Boiler shall be started and stopped automatically through the boiler control panel. Outdoor temperature sensor shall enable reset of heating water temperature in accordance with the following schedule:

Outdoor Air Temperature	Heating Water Temperature
70 degrees F	140 degrees F
0 degrees F	190 degrees F

3. Wire boiler burner through flow switch in heating water loop to prevent boiler operation until positive flow is proven.
4. Low water cutoff switch shall shut down boiler operation when water level drops below limit.

5. Automatic high limit shall shut down boiler operation when water temperature exceeds 200 degrees F (adjustable). Manual reset high limit shall shut down boiler operation when water temperature exceeds 205 degrees F (adjustable).
6. Install emergency shutdown switch near boiler room exit door. Wire switch through the burner controls.
7. Boiler shall have the capability for external hot water reset and enable via the BMS.

3.2 TESTING, CLEANING AND CERTIFICATION

A. Test boiler performance and adjust boiler combustion efficiency to meet manufacturer's recommendations.
   1. Measure and record the following:
      a. Gas pressure on manifold.
      b. Combustion air temperature at inlet to burner.
      c. Flue gas temperature at boiler discharge.
      d. Flue gas carbon dioxide and oxygen concentration
      e. Natural flue draft.

B. Flush and clean boilers according to manufacturer's instructions.

3.3 COMMISSIONING (DEMONSTRATION)

A. Provide 2 hours of instruction to university's representative. Include operation of boiler including accessories and controls, procedures for startup and shutdown, troubleshooting, servicing, and preventive maintenance. Review data in the maintenance manuals.

END OF SECTION 23 52 00

SECTION 237343.19 - OUTDOOR, CUSTOM AIR-HANDLING UNITS

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 outdoor, custom air-handling units with capacities, characteristics and configurations indicated on Drawings.

B. Related Requirements:

1. Section 237000 “Central HVAC Equipment."

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Product information organized to show compliance with each performance requirement of "Performance Requirements" article.

2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

4. Include unit dimensions and weight.

5. Include cabinet material, metal thickness, finishes, insulation, and accessories.

6. Fans:

a. Include certified fan-performance curves with system operating conditions indicated. For fans operating at variable speeds include curves in 10 percent speed increments starting at design speed down to minimum speed.

b. Include fan-sound power ratings in all eight octave bands. Include inlet or outlet sound power levels to coincide with sound requirements indicated on Drawings.

c. Include fan construction and accessories. Submit sufficient information to show product compliance with requirements indicated.

d. Include dimensions and weight.

e. Include motor ratings, electrical characteristics, and motor accessories.

7. Vibration isolation product data with performance ratings. Uniquely identify and include information for each different isolator type and indicate for each air-handling unit where each isolator type is being used.

8. Include certified coil-performance ratings with system operating conditions indicated. Product data to include: dimensions, dry and operating weight, volume of fluid contained, materials of construction, and performance ratings with system operating conditions indicated.

9. Casing insulation product data and performance ratings.

10. Access door and access panel product data and performance ratings.

11. Roofing product data and performance ratings.

12. Louver product data and performance ratings.

13. Paint product data and performance ratings.

14. Electrical product data and performance ratings.

15. Metal grating product data and performance ratings.

16. Dampers product data, including housings, linkages, and operators with performance ratings.

17. Filters product data with performance characteristics.

18. Heat wheels product data with performance ratings.

19. Fixed plate heat exchangers product data with performance ratings.

20. Heat pipe heat exchangers product data with performance ratings.

21. Air blender product data with dimensions, weights, materials of construction, performance ratings, and installation requirements.

22. UV-C lamp systems product data with performance ratings.

23. Pumps product data with performance ratings.

24. Hydronic pipe, valves, fittings, vents, strainers, and hydronic accessories product data.

25. Steam and condensate pipe, valves, fittings, vents, strainers, and steam specialties product data.

26. Pipe insulation and jacket product data.

27. Roof curbs product data.

B. Shop Drawings: For each type and configuration of indoor, custom air-handling unit.

1. Prepared by manufacturer's factory employees with review and sign-off by those individuals responsible for manufacturing the air-handling units.

2. Include plans, elevations, sections, and mounting details. For air-handling units consisting of multiple levels, create drawings for each level showing interrelationship of levels superimposed.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.

4. Detail fabrication and assembly of indoor, custom air-handling units, as well as procedures and diagrams.

5. Indicate details of construction with materials description including applicable specified standards and material grades in sufficient detail for reviewers to evaluate point by point compliance with requirements indicated for each air-handling unit.

6. Use actual dimensions of internal equipment in preparing Shop Drawings. Identify mechanical equipment shown on Shop Drawings with equipment designations on Drawings.

7. Thickness and finish of all casing materials with cross references indicated where each is used. Uniquely identify and include information for each different casing construction.

8. Details for each unique casing joint and reinforcing. Indicate wall joints, wall to floor joints, wall to roof joints, floor joints, and roof joints.

9. Roofing details.

10. Assembly details of base and casing for units consisting of multiple sections requiring field assembly.

11. Sizes and dimensioned locations of field connections for ductwork, piping, electrical, and controls.

12. Base and casing penetration and sealing details for factory-installed conduit.

13. Base and casing penetration and sealing details for factory-installed piping including coils.

14. Details of casing connections to field-installed ductwork.

15. Size, shape and layout of base members including localized support of internal components.

16. Base materials, thickness, finishes, lifting provisions, and mounting requirements. Uniquely identify and include information for each different base construction. Clearly indicate for each air-handling unit.

17. Recommended points of field attachment with dimensioned locations.

18. Size and location of each access door, including clearing opening size, with door swing indicated.

19. Size and location of each access panel with service equipment superimposed to show relationship of panel to internal equipment.

20. Drain pans and associated piping, with sizes and locations dimensioned, including relationship to internal equipment.

21. Floor drains and associated piping, with sizes and locations dimensioned, including relation to internal equipment.

22. Coil framework and support including enlarged details showing framework attachment to air-handling unit base, coil attachment to framework, and means for individual coil removal.

23. Mounting details of all internal components, such as fans, filters, and dampers.

24. Hoist rails layout for internal equipment showing size of members, attachments to structure, and serviced equipment superimposed to indicate relationships.

25. Size and location of catwalks, handrails, ladders, and safety cages including construction details and details of attachment to air-handling unit base.

26. Location of receptacles, service lights, and switches.

27. Location of motor controllers and disconnect switches.

28. Size and location of junction boxes used for interface with field electrical power.

29. Point-to-point electrical power wiring diagrams including wire size, conduit size, motor controllers sizes, switch types and ratings, receptacle types and ratings, service light fixture types and ratings.

30. Point-to-point control wiring diagrams including cable types and sizes, conduit sizes, and connected control devices.

31. Point-to-point control tubing diagrams including tubing types and sizes, conduit sizes, and connection controls devices.

32. Control panel drawings drawn to scale showing detailed internal layout.

33. Plans, sections and isometric reviews of hydronic and steam and condensate piping systems showing pipe, fittings, flanges, unions, valves, vents, strainers, accessories, specialties and insulation.

34. Indicate code, operating, and maintenance clearances drawn to scale using dashed lines.

35. Indicate weights of internal components, weight of each separately shipped section, and air-handling unit total weight.

C. Comparison Schedule:

1. Submit a schedule to indicate performance of equipment scheduled on Drawings directly compared to performance of submitted equipment.

2. Clearly identify each line in schedule to indicate "Scheduled" where indicating performance scheduled on Drawings and "Submitted" where indicating performance of submitted equipment.

3. Organize schedule to first indicate performance scheduled on Drawings on one line followed by line directly below that indicates performance of submitted equipment.

4. Comparison schedule shall follow arrangement and organization of scheduled information indicated on Drawings.

5. Submitted equipment shall have a value for each scheduled value indicated.

D. Delegated-Design Submittal: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Source quality-control reports.

C. Startup service reports.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Panel Filters: One set(s) for each air-handling unit.

2. Absolute Filters: One set(s) for each air-handling unit.

3. Access Door Gaskets: One set(s) for each access door.

4. Fan Belts: One set(s) for each fan with belt-drive assembly.

B. Tool Kit: Manufacturer to provide a tool kit including special tools required for air-handling unit service. See "Accessories" Article for additional requirements.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.8 FACTORY VISITS FOR PRODUCT INSPECTION

A. While units are being manufactured, and during factory normal working hours, allow escorted access to manufacturing facility for Owner and Owner's designated representative to verify product compliance with requirements indicated.

B. Manufacturer shall provide Owner and Architect with written notice at least 30 business days before units go into assembly.

C. Inspection visits shall be scheduled with manufacturer at least 10 business days before visit.

D. Personnel making visits for purposes of product inspection shall comply with manufacturer requirements for visitors.

1.9 DELIVERY, STORAGE, HANDLING

A. Deliver air-handling units with factory-installed shipping skids and lifting lugs; pack small components in factory-fabricated protective containers. Cover units with heat-shrinkable plastic sheeting suitable for shipping from point of manufacture to Project.

B. Handle air-handling units carefully to avoid damage to components, casing, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.

C. Store air-handling units in a clean dry place and protect them from weather and construction activities.

D. Keep air-handling units fully covered and protected during construction. Remove dirt and debris and clean units to a factory-cleaned condition.

E. Comply with manufacturer's written rigging and installation instructions for unloading air-handling units and moving them to their final locations.

F. For air-handling units equipped with key locks on access doors, keep doors locked during construction.

1. If access is required within air-handling units, only open the doors to sections that require access and lock doors at the end of each workday.

2. Protect inside of air-handling units from damage and keep inside of units as clean as the factory-cleaned condition.

1.10 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of air-handling units that fails in materials or workmanship within specified warranty period.

B. Extended warranties include, but are not limited to, the following:

1. Complete Air-Handling Unit: Two years from date of Substantial Completion for entire air-handling unit and longer where indicated for individual components.

2. Air-Handling Unit Casing: 25 years from date of Substantial Completion.

3. Air-Handling Unit Roofing: 25 years from date of Substantial Completion.

4. Motors: Two years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handing units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design air-handling units, vibration isolation, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

F. Casing Structural Performance:

1. Floor: Capable of withstanding positive/negative 8 inches wg (2000 Pa) of internal static pressure, without exceeding a deflection of L/300 of span.

2. Walls and Roof: Capable of withstanding positive/negative 8 inches wg (2000 Pa) of internal static pressure, without exceeding a midpoint deflection of L/200 of span.

G. Casing Leakage Performance, ASHRAE 111: Class 3 leakage or better at plus or minus 8 inches wg (2000 Pa).

H. Casing Leakage Performance: Comply with more stringent of the following requirements:

1. ASHRAE 111, Class 3 leakage or better at plus or minus 8 inches wg (2000 Pa).

2. Not more than 0.5 percent of the total unit airflow at 8 inches wg (2000 Pa).

I. Casing Thermal Performance:

1. Surface Condensation: Air-handling manufacturer shall evaluate potential for condensation and design and manufacture entire unit casing to prevent condensation at most extreme operating conditions encountered.

2. Thermal Break: Incorporate a thermal break at each through metal path to prevent condensation from occurring on interior and exterior of casing.

3. U-Value: Overall U-value or equivalent R-value of casing shall not exceed governing codes and ASHRAE/IES 90.1 while considering the effects of metal-to-metal contact and thermal bridging in calculations.

J. Air Tunnel Aerodynamic Performance: Position air-handling unit internal components and transition between internal components to maintain uniform airflow; minimize sound levels and energy consumption. Use methods indicated and other means to ensure compliance.

1. Use turning vanes if necessary to direct the air path.

a. Design, manufacture, and install vanes in accordance with applicable requirements in ASHRAE and SMACNA guidelines, handbooks, and standards.

b. Install vanes firmly in place so that no vane movement occurs at worst-case airflow capacity possible.

2. Use fan inlet and discharge transitions and other devices to maximize system regain and minimize airborne sound levels.

3. Center system components such as coils, fans, and filters, vertically and horizontally, in the airstream.

4. Maintain spacing between components such that airflow patterns to adjacent components are as uniform as possible and that component "dead spots" or "jetted areas" are avoided.

5. Design and install internal structural supports, piping, and conduit that do not block airflow and impede performance of coils, fans, filters, and other unit components, and service space clearances.

K. Durability Performance: Design and manufacture air-handling units with underlying requirement to provide a highly durable piece of equipment.

1. Unit Life Expectancy: 25 years.

2. Supporting Documentation: Submit documentation showing proposed products to consider and include design features, components, and materials to satisfy requirement.

L. Extreme Operating Conditions:

1. Corrosive Environments: Air-handling unit manufacturer shall evaluate the quality and potential corrosiveness of air passing through air-handling units and propose additional protective finishes and better-quality materials of a heavier thickness if required to comply with requirements indicated.

a. Unless otherwise indicated, air-handling units for HVAC applications may use up to 100 percent of outdoor air or a mix of outdoor air with return air from habitable areas served.

b. Air-handling units circulating Class 3 and Class 4 exhaust air in accordance with ASHRAE 62.1 could potentially be hot, humid, and corrosive and may require added protection.

2. Humidity and Temperatures: Materials and components of air-handling units shall be suitable for use in low and high humidity and temperature extremes when operating under normal and abnormal conditions without permanent degradation or loss in material performance.

M. Outdoor Environment:

1. Air-handling units specially designed to withstand effects of wind, rain, ice, snow, seismic, air quality, sun, and other influences associated with outdoor installations.

2. Comply with requirements of air-handling unit and governing codes.

N. Safety:

1. Comply with OSHA regulations.

2. Exposed sharp edges and corners of metal shall be protected or rounded to prevent injury to personnel not wearing gloves.

3. Cover exposed ends of screws with plastic or metal covers to prevent injury to personnel coming in contact with screws.

O. Serviceability:

1. Hoisting Provisions: Fans and motors weighing more than 200 lb (91 kg) shall have full-length hoist rails mounted over the equipment to facilitate service, removal, and replacement.

2. Mounting Location: Install internal components in readily accessible locations to facilitate ease of service and replacement.

3. Service Access:

a. Internal components shall be serviceable through access sections with doors indicated on Drawings.

b. Internal components shall be removable and replaceable through access doors or panels.

c. Review requirements for access doors and panels indicated and recommend additional access doors and panels if required for uninhabited service, removal, and replacement of components.

4. Tripping Hazards: Floors in accessible sections of air-handling unit shall be free of standing seams, reinforcing, supports, or section splits located in the walking path that is capable of causing a tripping hazard. Locate section splits immediately adjacent to internal walls.

P. Quality: Type and thickness of materials indicated are the minimum acceptable. Provide better-quality materials of a heavier thickness if required to comply with performance requirements indicated.

1. If manufacturer's standard construction exceeds requirements indicated, use manufacturer's standard construction.

2. If manufacturer's standard construction does not comply with requirements indicated, modify manufacturer's standard construction to comply with requirements.

Q. Vibration Performance: Air-handling unit manufacturer shall evaluate vibration of internal components installed inside of air-handling units and include internal vibration isolation required to limit the vibration transmitted to the building at a low enough level that vibration is not perceived by building occupants.

2.2 CAPACITIES AND CHARACTERISTICS

A. See equipment schedules on Drawings.

2.3 SOURCE LIMITATIONS

A. Source all outdoor custom air-handling units from same manufacturer.

B. Like components furnished with air-handling units shall be from same manufacturer.

2.4 UNIT ARRANGEMENT AND CONFIGURATION

A. Arrangement: Project-specific arrangement and configuration of air-handling units indicated on Drawings. Do not deviate from requirements indicated without submitting a formal request clearly describing each deviation and reason for each deviation, and only after receiving Architect's written acceptance.

B. Mounting Requirements: Units mounted on roof curbs.

C. Multiple Sections: Each air-handling unit shall consist of multiple sections for field assembly to comply with requirements indicated on Drawings.

D. Multiple Sections, Splits: Air-handling unit manufacturer to determine number of sections and location of section splits required for each air-handling unit in accordance with the following criteria:

1. Physical size and weight of each section, on-site path of travel, and methods for erection and installation. Air-handling manufacturer to review criteria with Installer before preparing Shop Drawings.

2. Maximize physical size of each air-handling unit section considering, shipping, moving, erecting, and installation.

3. Minimize the number of air-handling unit sections requiring field assembly. Preference is for single-piece air-handling units where possible.

2.5 AIR-HANDLING UNIT BASE

A. Performance:

1. Air-handling unit manufacturer shall design and assemble air-handing unit casing and internal components for attachment and support by air-handling unit structural base.

2. Design air-handling units to be lifted from only the air-handling unit structural base and not the casing.

3. Support air-handling units from only the perimeter base unless otherwise indicated on Drawings.

4. Air-handling unit manufacturer to size and locate intermediate structural base supports as required to comply with structural performance indicated for air-handling unit floors.

5. Level base before factory assembly of air-handling unit casing and internal components to ensure proper fit and alignment.

B. Structural Member Size:

1. Air-handling unit manufacturer shall select size of base members and construction of base to withstand the rigors of loading, unloading, shipping, and rigging without damage to air-handling unit components or misalignment of factory-assembled components.

2. Depth and weight of structural members shall be selected by air-handling unit manufacturer to comply with performance requirements indicated.

3. Depth of perimeter base members is not less than 1/10 of the unit width.

C. Structural Member Spacing: Positioned as required to comply with requirements indicated, but not to exceed 24 inches (600 mm).

D. Materials: Structural aluminum, ASTM B209 (ASTM B209M), Alloy 6061 T6 or structural stainless steel, ASTM A276/A276M, Type 316L.

1. Perimeter Members: channel or I or W beam shapes or tube.

2. Intermediate Members (Spanning Full Width of Unit): channel or I or W beam shapes or tube.

3. Cross Members (Spanning Intermediate Members): channel or tube.

E. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.

1. Use welding materials with corrosion properties equal to material being welded.

F. Welding Procedures:

1. Structural Welding Codes: AWS D1.2/D1.2M for aluminum AWS D1.6/D1.6M for stainless steel.

2. Join structural members to one another using continuous welds.

3. After welding and fabrication, deburr and grind exposed welds to provide smooth surfaces free of sharp edges.

G. Penetrations through Base Perimeter: Seal pipe, tubing, and conduit penetrations through base perimeter members to provide a watertight assembly.

H. Section Joints: Air-handling units consisting of multiple sections for field assembly shall be joined with structural joining plates.

1. Joining plate material type to match base.

2. Joining plate of thickness required to join sections without resulting in a permanent deflection, minimum 1/2 inch (13 mm) thick.

3. Continuously weld joining plates to each mating end of base.

4. Joining plates shall not extend beyond outer edge of adjoining base.

5. Plates to include at least three equally spaced holes for field connection using factory-furnished threaded hardware of a nominal diameter of at least 1/2 inch (13 mm).

I. Lifting Provisions: Air-handling unit manufacturer to design and install lifting lugs of size and location required to comply with performance requirements indicated. Lifting lugs extending beyond the base shall be easily removable in the field after unit is installed.

J. Curb Cap:

1. For air-handling units installed on a continuous perimeter curb, provide air-handling unit base with a continuous structural angle counterflashing.

2. Angle shall extend down vertical face of curb to completely cover wood nailer.

3. Coordinate inside dimension of angle counterflashing with curb dimension and roofing. Provide adequate clearance between angle counterflashing and roofing over curb.

2.6 UNIT CASINGS

A. Casing Assembly:

1. Appearance:

a. Exposed exterior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.25 inch (7 mm) beyond the exterior skin surface.

b. Underside of air-handling units with finished installation exposed to view shall have finished appearance matching casing walls. Casing shall be recessed within the perimeter structural base to provide a single contiguous plane.

c. Interior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.25 inch (7 mm) beyond the skin surface.

2. Dissimilar Metals: Isolate dissimilar metals that are in contact to prevent galvanic action and corrosion.

3. Framing and Supports: Interconnect and support individual casing wall and roof panels using either formed panel construction or framed construction with structural support members. For framed casing construction, materials used to construct casing of structural support members shall be as follows:

    a. Casings with Aluminum Outer and Inner Skins: Aluminum extrusions in accordance with ASTM B211 Alloy 6063 T6.

    b. Casings with Galvanized-Steel Outer and Inner Skins: Galvanized steel.

    c. Casings with Galvanized-Steel Outer Skin and Aluminum or Stainless Steel Inner Skins: Stainless steel.

    d. Casings with Stainless Steel Outer and Inner Skins: Stainless steel.

4. Seals: Seal interior and exterior joints and seams to make casing air- and watertight. Trim factory-applied sealant flush with adjacent surface.

5. Double-Wall Casings: Consisting of insulation sandwiched between an outer and inner metal wall. Use double-wall casings to construct air-handling units unless septum casings are required.

6. Septum Casings: Triple-wall construction consisting of a solid metal inner wall sandwiched between insulation layers that are covered with metal walls. Use septum casings for applications having performance requirements that are not achievable with double-wall casings.

7. Penetrations: Seal voids around conduit, piping and tubing penetrations.

    a. Walls and Roofs:

        1) Conduit, Pipe, and Tube Sizes NPS 3 (DN 80) and Smaller:

            a) Seal void through casing with a nonhardening vapor-barrier caulk covered by an escutcheon on both interior and exterior sides of casing. Back caulk using formed insulation within a sheet metal sleeve.
            b) Seal void using a friction fit neoprene or EPDM sheet material attached to casing using a bed of adhesive.
            c) Cover penetration and sealing sheet material with metal escutcheon matching adjacent casing material.

        2) Larger Conduit, Pipe, and Tube Sizes: Seal annular void using an adjustable compression-type sealing sleeve.

    b. Floors: Route conduit, pipe, and tube within a floor-mounted pipe sleeve.

        1) Sleeve:

            a) Fabricate sleeve of aluminum, galvanized-steel, or stainless steel pipe.

b) Extend top of sleeve above adjacent floor surface to prevent standing water on floor from entering annular space of sleeve.
c) Seal sleeve to top of floor for an air- and watertight seal.

2) Seal annular void of sleeve using an adjustable compression seal or nonhardening packing material.

8. Floor Openings with Metal Grating:

a. Factory install walk-on safety gratings over any floor opening large enough to create a safety hazard for operators including, but not be limited to, supply-, return-, and exhaust-air openings.

b. Bar Grating:

1) Materials: Use stainless steel grating for aluminum hot-dip galvanized-steel grating for galvanized-steel floors.

2) Air-handling unit manufacturer shall select depth and thickness of grating bars to limit deflection to 1/360 of span when subjected to a dynamic load of not less than 500 lb (227 kg).

3) Industry-standard welded grating with bars at least 1-1/2 inches (38 mm) deep by at least 3/16 inch (5 mm) thick with nominal 1-3/16-inch (30-mm) main bar spacing and 4-inch (100-mm) cross bar spacing.

4) Source: Product manufacturer specializing in metal gratings.

5) Grating bearing surface shall extend beyond clear opening in floor at least 2 inches (50 mm).

c. Mounting Frame:

1) Mount grating in a continuous structural angle or bar frame so no ends of grating bars are exposed. Top of frame to be flush with top of grating.

2) Secure grating to frame with threaded hardware so grating does not move when walked on but can be easily removed from top to gain access behind grating.

3) Continuously weld mounting frame to air-handling unit floor.

4) Fasten mounting frame to air-handling unit floor with hardware and seal attachment air- and watertight.

5) For applications with automatic dampers installed at floor openings, elevate height of mounting frame and grating to enclose entire damper assembly including jackshaft so walk-on surface of grating is above damper assembly.

9. Waterproof Floors: Continuously weld floor joints, seams, and penetrations to completely seal floor. Roll all edges of floor up at least 1 inch (25 mm) to create a shallow tub capable of holding standing water.

10. Duct Connections - Direct to Casing: Frame and reinforce unit casing around perimeter of unit duct openings to accommodate direct attachment of field-installed ductwork. Coordinate requirements with Installer to accommodate field connection.

11. Duct Connections - Elevated Off Casing:

    a. Terminate with angle flange face elevated 3 inches (75 mm) from exterior surface of casing.

    b. Flange Thickness: 0.25 inch (6 mm).

    c. Flange face with holes located not more than 4 inches (100 mm) o.c., starting at corners, and sized for 0.375-inch- (9-mm-) diameter, field-installed hardware.

    d. Size flange face to mate to full face of duct flange.

        1) Clear inside dimension of unit connection to match clear inside dimension of duct.

        2) For connections to acoustically lined ducts, increase unit flange face to accommodate thickness of liner so end of duct liner is concealed by air-handling unit flange.

B. Materials for Outer Skin of Casing Walls and Roofs:

1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 (Z275) coating; minimum (nominal) 18 gauge (1.3 mm) thick.

2. Aluminum Solid Sheet: ASTM B209 (ASTM B209M); Alloy 3003-H14, smooth or leather-grain texture finish; minimum (nominal) 0.063 inch (1.6 mm) thick.

3. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304; No. 2D or 4 finish; minimum (nominal) 18 gauge (1.3 mm) thick.

C. Materials for Inner Skin of Casing Walls and Roofs:

1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 (Z275) coating, minimum (nominal) 18 gauge (1.3 mm) thick.

2. Aluminum Solid Sheet: ASTM B209 (ASTM B209M); Alloy 3003-H14, smooth finish; minimum (nominal) 0.040 inch (1.1 mm) thick.

3. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M; Type 304; No. 2D finish; minimum (nominal) 18 gauge (1.3 mm) thick.

4. Application: See Drawings for application of different materials indicated.

D. Materials for Floor Walking Surface:

1. Aluminum Diamond Treadplate: ASTM B632/B632M, Alloy 6061 T6; mill finish; minimum (nominal) 0.125 inch (3.2 mm) thick.

2. Stainless Steel Diamond Treadplate: ASTM A793; Type 304; mill finish; minimum (nominal) 0.125 inch (3.2 mm) thick.

3. Application: See Drawings for application of different materials indicated.

E. Materials for Underside of Floor Insulation:

1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 (Z275) coating, minimum (nominal) 18 gauge (1.3 mm) thick.

2. Aluminum Solid Sheet: ASTM B209 (ASTM B209M); Alloy 3003-H14, smooth finish; minimum (nominal) 0.063 inch (1.6 mm) thick.

3. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M; Type 304; No. 2D finish; minimum (nominal) 18 gauge (1.3 mm) thick.

F. Materials for Internal Walls:

1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 (Z275) coating; minimum (nominal) 16 gauge (1.6 mm) thick.

2. Aluminum Solid Sheet: ASTM B209 (ASTM B209M); Alloy 3003-H14, smooth finish; minimum (nominal) 0.063 inch (1.6 mm) thick.

3. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304; No. 2D finish; minimum (nominal) 16 gauge (1.6 mm) thick.

G. Surfaces in Contact with Airstream:

1. Comply with ASHRAE 62.1 and NFPA 90A.

2. Glass or mineral-fiber insulation installed behind perforated metal shall be encapsulated to prevent insulation fibers from entering the airstream by using a polymer sheet material or tightly woven glass cloth material that does not impact the acoustical absorption properties of insulation.

H. Insulation for Casing Walls and Roofs Not Exposed to Airstream:

1. Materials Not Exposed to Airstream: injected or sprayed polyurethane foam insulation with a minimum nominal density of 2 lb/cu. ft. (32 kg/cu. m).

2. R-Value: Minimum R-12.

3. Thickness: Minimum 2 inches (50 mm).

4. Insulation shall completely fill the casing cavity so no voids exist.

I. Insulation for Casing Walls and Roofs Exposed to Airstream:

1. Materials Exposed to Airstream: Glass or mineral-fiber board insulation with a minimum density of 2 lb/cu. ft. (32 kg/cu. m).

2. R-Value: Minimum R-12.

3. Thickness: Minimum 2 inches (50 mm).

4. Insulation shall completely fill the casing cavity so no voids exist.

J. Insulation for Casing Floors:

1. Materials: injected or sprayed polyurethane foam insulation with a minimum nominal density of 2 lb/cu. ft. (32 kg/cu. m).

2. R-Value: Minimum R-12.

3. Thickness: Minimum 2 inches (50 mm).

4. Insulation shall completely fill the casing cavity so no voids exist.

K. Access Doors:

1. Application: Install access doors in air-handling units at locations indicated on Drawings.

2. Adjustment: Design doors for field adjustment capable of maintaining specified leakage rate.

3. Mounting Height: Install bottom of door frame within 2 inches (50 mm) of air-handling unit floor walking surface. Where internal conditions require access doors to be mounted higher above air-handling unit floor, include permanent retractable stairs inside and outside of air-handling unit to limit stair risers to 6 inches (150 mm).

4. Performance: Leakage as required to satisfy overall unit leakage performance indicated, but not more than 1.0 cfm (0.47 L/s) per door when tested at 10 inches wg (2500 kPa).

5. Fabrication: Formed and reinforced, constructed of same materials and thicknesses as casing.

6. Swing: Arrange doors to be opened against pressure, unless otherwise indicated on Drawings.

7. Frame: stainless steel with welded mitered corners.

8. Handles:

a. Secure door closed using not less than two roller-style latches with handles located at quarter points along door height.

b. If three latches with handles are included, install one at midpoint of door height and equally space others.

c. Air-handling unit manufacturer has option to use a multipoint latching mechanism that is operable from a single door handle located at midpoint of door height, but secures door to frame at top, bottom, and handle location.

d. Include door handles on outside and inside of door to allow operator access to open and close door from outside and inside of unit.

e. Field adjustable to accommodate changes to fit and gasket compression.

f. Durable product capable of withstanding repeated opening and closing of door while operating under design pressure without damage.

9. Hinges: minimum of three hinges.

10. Gasket:

a. Design: Specially formed with an internal air chamber specifically designed to seal on two surfaces without taking a permanent set.

b. Dual Gaskets: Primary and secondary gasket.

c. Location: Install gaskets around entire perimeter of doors or frames.

d. Material: EPDM, neoprene, or santoprene.

e. Protection: Seat gasket in a protective metal ribbed chamber integral to door or door frame to protect gasket from damage by operator incidental contact.

f. Service: Field replaceable.

g. Adhesive-backed tape-type gaskets adhered to a single flat surface are unacceptable.

11. Size of Door Frame Clear Opening: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.

a. Width: At least 24 inches (600 mm) clear inside of door frame.

b. Height: Full clear height of unit casing up to a maximum height of 72 inches (1800 mm) clear inside of door frame.

c. Door sizes indicated on Drawings.

12. Safety Latches and Stops:

a. Safety Latches: Install safety latch with retainers on outward swing doors that do not open against pressure to allow restricted travel for purpose of pressure relief and so that doors do not open uncontrollably due to inside pressure.

b. Stops: Install cushioned door stops on inward swinging doors where necessary to limit door travel that could potentially damage the door or internal components.

13. Tie-Backs: Install tie-backs with retainers on outward-swinging access doors to hold doors in an open position during service.

14. Locks: Include each access door with an integral key lock. Pad locks are unacceptable.

a. Incorporate key lock into door handle where feature is available.

b. A common key shall be used to lock and unlock access doors of air-handling unit.

c. Include three keys.

d. Lock access doors at factory to ensure that unauthorized access is in place before air-handling unit packaging and shipment.

15. Windows:

a. Construction: Fabricate windows with frame mounted in access doors of double-glazed safety glass with an airspace between panes and interior and exterior seals.

b. Condensation Control: Install desiccant material in airspace between panes if necessary to prevent condensation from forming on glazing.

c. Clear Viewing Size: Minimum 8 inches (200 mm), square.

d. Mounting Location: Center window in door width. For doors up to 60 inches (1500 mm) high, locate top of window 6 inches (150 mm) below top of door. For taller doors, locate center of windows at optimal viewing height, approximately 60 inches (1500 mm) above floor adjacent to unit.

e. Application: Install windows in all access doors.

16. Nameplates:

a. On each access door, include a nameplate defining the access to service within. Nameplates shall be included for, but not be limited to, the following:

1) Dampers.

2) Filters.

3) Cooling Coils.

4) Heating Coils.

5) Fixed Plate Exchangers.

6) Supply Fans.

7) Exhaust Fans.

8) Air-handling unit designation.

9) Where door access is to multiple components, list all components accessed. For example: Filter/Cooling Coil.

10) For each door that does not open against static pressure, include a warning sign stating: "DANGER: DOOR UNDER PRESSURE. DO NOT OPEN WITH FAN ON."

b. Lettering Size and Style: At least 1-inch- (25-mm-) high, block style.

c. Material: Lettering engraved in black plastic on a white plastic back. Engraving shall penetrate through black plastic so lettering reads white.

d. Attachment: Attach nameplates to door using high-strength bonding cement and stainless steel screws.

e. Mounting Location:

1) For access doors without windows, locate top of nameplate 6 inches (150 mm) from top of door and center in door width.

2) For access doors with windows, locate nameplate directly below window frame and center in door width.

3) Align nameplates of all doors for uniform placement.

L. Access Door Gutters and Downspouts: Install rain gutters directly above each access door to deflect rain away from doors.

1. Construct gutters of same materials and finish as casing exterior.

2. Extend gutters beyond vertical edge of doors at least 3 inches (75 mm).

3. Install gutter with a downspout located adjacent to access door frame. Construct downspout of aluminum pipe of a size determined by unit manufacturer. Terminate downspout at a height below unit floor.

M. Access Panels:

1. Performance: Leakage as required to satisfy overall unit leakage performance indicated.

2. Fabrication: Formed and reinforced panels of same material and thickness as casing.

3. Fasteners: Adjustable, reusable type for multiple operations without degradation due to reuse. Do not use screws capable of stripping.

4. Arrangement: Panels removable from exterior side of casing.

5. Gasket: EPDM, neoprene, or santoprene similar to access doors, applied around entire perimeter of panels or frames.

6. Location and Size:

   a. Coils: Oversized access panel to allow removal and replacement without impacting adjacent casing.

   b. Fans: Oversized access panel to allow removal and replacement of entire fan assembly including base without impacting adjacent casing.

   c. Heat Wheels and Heat Exchangers: Oversized access panel to allow removal and replacement of internal components without impacting adjacent casing.

7. Nameplates:

   a. On each access panel, include a nameplate defining the access to service within. Nameplates shall be included for, but not be limited to, the following:

      1) Cooling Coils.

      2) Heating Coils.

      3) Fixed Plate Exchangers.

      4) Supply Fans.

      5) Exhaust Fans.

N. Standing-Seam Metal Roof: Construct air-handling unit roof casing with standing seams designed for waterproof roofing applications.

1. Construct air-handling unit roof using same materials and finish as walls.

2. Slope roof away from primary access side of unit at not less than 1 percent.

3. For air-handling units shipped in multiple sections, include standing-seam joiners at each split with adhesive, hardware, and cover strips for field joining by Installer.

O. Roofing Membrane:

1. Cover entire roof with a roofing membrane. Extend membrane down sides of unit a sufficient distance to provide a waterproof roof assembly and secure in place with a metal flashing matching casing material and finish.

    a. Roofing membrane shall have an elongation of at least 450 percent when tested in accordance with ASTM D412.

    b. Roofing membrane shall not become brittle at temperatures down to minus 40 deg F (40 deg C).

2. Slope unit roof away from primary access side of unit at a slope in accordance with roofing manufacturer's written instructions, but not less than 1 percent.

3. Application: Factory or field applied as determined by air-handling unit manufacturer; in accordance with roof manufacturer's written instructions.

    a. Field-applied roofing to be supervised by an air-handling unit manufacturer's factory service representative.

P. Liquid-Applied Roofing:

1. Cover entire roof with a liquid-applied roofing. Extend liquid-applied roofing down sides of unit a sufficient distance to provide a waterproof roof assembly and cover sides with a metal flashing matching casing material and finish.

    a. Cured roofing shall have an elongation of at least 500 percent at 77 deg F (25 deg C) and at least 300 percent at 0 deg F (minus 17 deg C), when tested in accordance with ASTM D412.

    b. Roofing shall not become brittle at temperatures down to minus 40 deg F (40 deg C).

2. Slope unit roof away from primary access side of unit at a slope in accordance with roofing manufacturer's written instructions, but not less than 1 percent.

3. Application: Factory or field applied as determined by air-handling unit manufacturer; in accordance with roof manufacturer's written instructions.

    a. Field-applied roofing to be supervised by an air-handling unit manufacturer's factory service representative.

Q. Piping Enclosures:

1. Description: Integral accessible enclosure(s) to house field-installed piping from below and connecting to hydronic coils.

2. Size: Adequate clearance for field installation of piping, valves, accessories, and associated insulation.

a. Maintain at least 6 inches (150 mm) of clearance between inside of enclosure and face of pipe insulation at most restricted point.

3. Construction:

a. Base, Walls, and Roof: Match air-handling unit.

b. Floor: Not required, open to below.

c. Access Doors:

1) Size for full front access to piping, valves, and accessories installed within enclosure.

2) Double-door applications with removable center mullions for unrestricted access.

4. Electrical: Factory install and wire service light with switch and receptacle for each enclosure.

2.7 WALL LOUVERS

A. Wall Louvers, Wind-Driven Rain:

1. Source Limitations: Obtain louvers from single source from single manufacturer.

2. Performance:

a. Air Pressure Drop, Design: Less than 0.1 inch wg (2.5 Pa) at airflow indicated on Drawings.

b. Air Pressure Drop, Rating: Less than 0.1 inch wg (2.5 Pa) at free area intake face velocity of 800 fpm (4.1 m/s).

c. Face Velocity: If louver size is not indicated on Drawings, size louver for 500-fpm (2.5-m/s) velocity across louver free area.

d. Free Area: 47 percent or more for a 48-by-48-inch (1200-by-1200-mm) representative sample.

e. AMCA 500-L:

1) Wind-Driven Rain Penetration Class: Class A, with wind-driven rain penetration effectiveness of 99 percent at core velocity up to 408 fpm (2.1 m/s) with 50-mph (80-kph) wind and rainfall of 8 inches (200 mm) per hour.

2) Intake Discharge Loss Class: Class 2.

3. Features:

   a. Depth: 5 inches (125 mm).

   b. Frame: 0.080 inch (2 mm) thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy.

   c. Blades: 0.063 inch (1.6 mm) thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy; stationary in horizontal position, double drainable, and sightproof.

   d. Stationary vertically positioned blades.

   e. Bird Screen: 0.5-by-0.040-inch (13-by-1.0-mm) expanded flattened aluminum attached to back of louver.

   f. Finish: Match exterior casing.

4. Air-Handling Unit Factory Assembly:

   a. Install louver face flush with exterior of casing and seal to provide a weathertight installation.

   b. Secure louver in casing and include additional bracing if required to handle loading of extreme outdoor environmental performance indicated.

5. Application: Factory install louvers in air-handling casing at locations indicated on Drawings and for each outdoor intake and exhaust discharge.

2.8 INTERNAL STRUCTURAL SUPPORTS

A. General:

1. Air-handling unit manufacturer shall design and assemble air-handing unit internal structural supports for attachment and support by air-handling unit structural base.

2. Factory install structural supports for internal support casing if required to comply with casing structural performance.

3. Factory install hoist beams and rails over equipment to comply with performance requirements for service.

B. Structural Member Size and Spacing:

1. Size: Air-handling unit manufacturer shall select size of members and construction to do the following:

a. Withstand the rigors of loading, unloading, shipping and rigging without damage to air-handling unit components or misalignment of factory-assembled casing and components.

b. Comply with performance requirements indicated.

2. Spacing: Positioned as required to comply with requirements.

C. Materials: Structural aluminum, ASTM B209 (ASTM B209M), Alloy 6061 T6 or structural stainless steel, ASTM A276/A276M, Type 316L.

1. Structural Supports: channel or I or W beam shapes or tube shapes selected by air-handling unit manufacturer for application.

2. Hoist Beams for Internal Components (Spanning Full Width of Unit): I or W beam shapes.

2.9 FACTORY-MANUFACTURED ROOF CURBS

A. General:

1. Air-handling unit manufacturer shall furnish a continuous perimeter curb for each air-handling unit.

2. Design curb to support operating air-handling unit from its base with attachments to withstand environmental forces. Curbs with intermediate reinforcing as required.

3. Frame curb for ductwork, piping, and conduit located within curb.

4. Fabricate curb to maintain top of curb level even where installed on sloping substrate.

5. Furnish top of curb to provide for field attachment of unit base to curb.

6. Furnish curb with a fully mitered and raised cant where required by adjacent insulation and roofing.

7. Include bottom of curb with attachment flange that extends beyond base of curb and is suitable for attachment to substrate.

8. Furnish curb with integral crickets if required by roof installation.

B. Size:

1. Size curb to provide continuous support of unit base and to fit within footprint of unit perimeter base.

2. Height: See Drawings.

3. Height: 12 inches (300 mm) from top of curb to finished roofing surface at highest point along perimeter of curb.

C. Materials:

1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 (Z275) coating; minimum (nominal) 14 gauge (2.0 mm) thick. Treat welded areas to protect against corrosion with a zinc-rich coating.

2. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304 grade; No. 2D finish; minimum (nominal) 14 gauge (2.0 mm) thick.

D. Insulation:

1. Insulate curb to provide thermal performance equal to unit casing.

2. Completely encapsulate insulation within metal curb.

E. Gaskets:

1. Include a continuous gasket between air-handling unit base and top of curb for an air and watertight seal.

2. Select gasket materials suitable for installation while complying with requirements indicated.

3. Furnish gasket materials with air-handling units and curbs for field installation.

4. Air-handling unit manufacturer to provide instruction to installer on proper installation techniques.

2.10 CENTRIFUGAL FAN ARRAYS

A. Sourcing Option: In lieu of sourcing fan array assemblies from a specialty fan manufacturer, air-handling unit manufacturer has option to furnish in-house fan array assemblies that achieve equal or better performance while complying with other requirements indicated.

B. Operating Performance:

1. Air-handling unit manufacturer shall account for, and include in, submitted fan selections any static pressure drops associated with unit, and system effect due to fan operating in the air-handling unit.

2. Add additional static pressure to fan scheduled total static pressure.

3. If fan motor horsepower is increased, notify Architect.

4. Fans shall have sharply rising pressure characteristics at operating point and stable in operation. Fan horsepower characteristics shall be self-limiting and non-loading.

5. Fan speed, brake horsepower, and sound power levels indicated are maximum acceptable.

6. Scheduled motor horsepower, airflow rate, and static pressure are minimum acceptable. Motor horsepower shall be capable of handling maximum horsepower of fan at scheduled speed.

7. At a minimum, fans shall have AMCA class indicated on Drawings.

    a. Fan operating limits shall be in accordance with AMCA 99 for AMCA class indicated.

    b. If AMCA class is not indicated, use AMCA 99 as basis for determining AMCA class.

    c. AMCA class selected shall be capable of accommodating a plus 10 percent increase to fan static pressure indicated on Drawings.

8. Motor starting torque shall exceed fan speed-torque requirements.

9. Airflow Profile:

    a. Fan arrangement within fan array shall produce a uniform airflow and velocity profile across air-handling unit air tunnel when measured 12 inches (300 mm) upstream of fan inlet and 48 inches (1200 mm) downstream of fan inlet.

C. Vibration Balance:

1. Each fan/motor assembly shall be factory balanced to AMCA 204, BV-5, Balance Quality Grade G1.0 or better through entire operating speed range from minimum speed to maximum speed. If minimum speed is not indicated on Drawings, assume minimum speed to be 20 percent of design speed.

2. Identify and record each speed and speed range within the fan operating range that could cause potential vibration problems.

3. Submit test reports as an informational submittal for Project record.

D. Vibration Isolation: Install vibration isolation on each fan/motor assembly in the fan array, except vibration isolation may be omitted on fans/motor assemblies balanced to AMCA 204, BV-5, with a maximum residual imbalance of 0.22-in./s (5.6-mm/s) peak, filter in.

E. Operation and Service Requirements:

1. Remaining fans in array shall continue to operate with one or multiple failed fans.

2. Each fan/motor assembly of fan array shall be capable of lock-out/tag-out procedure without interrupting operation of other fans in the array.

3. Each fan/motor assembly shall be controlled through a variable-frequency controller, except for fans with electronically commutated (EC) motors having integral motor controls.

    a. Include a dedicated variable-frequency controller for each fan/motor assembly in the fan array.

    b. If fan array is served from a single variable-frequency controller, include a redundant variable-frequency controller with automatic switchover in event of primary variable-frequency controller failure.

4. A single mechanical, electrical, and control device failure shall not result in a fan array available capacity of less than 33 percent of air-handling unit total scheduled airflow capacity.

5. Fan wheel/motor assembly shall pass through the air-handling unit access door servicing fans. Entire individual fan assembly shall pass through the door to the room where air-handling unit is located.

6. Design and incorporate features to permit safe, rapid, and economical maintenance.

F. Airflow Measurement, Local Indication, and Remote Monitoring:

1. Each fan within fan array shall include airflow measurement indication in cfm (L/s).

2. Include airflow totalization of all operating fans in fan array.

3. Airflow measurement instrumentation shall not restrict or deflect air travel through fan and shall not impact fan air and sound performance.

4. Include digital display of individual fan airflow and total fan array airflow on face of fan control panel.

5. Include a 4- to 20-mAoutput signal for remote monitoring of total fan array airflow.

G. Fan Array Local Control:

1. Include fan control panel with operator interface to control fan array locally through the fan control panel and to switch to control of fan array through a remote-control source.

2. Local control shall include on/off operation and speed adjustment for entire fan array and each individual fan/motor in fan array.

H. Fan Array Remote Control:

1. Include fan control panel with control interface for remote control.

2. Fan array on/off operation shall be remotely controlled through a single hardwired digital output signal.

3. Fan array speed shall be remotely controlled through a single hardwired analog (4- to 20-mA) output signal.

I. Fan Base, Stackable Fan Units:

1. Mount fan/motor on galvanized-steel or powder-coated steel base.

2. Include base and vibration isolators in accordance with requirements indicated.

3. Weld structural members to form a rigid base.

4. Size and design the base construction to withstand the rigors of shipping and rigging.

5. Include the base with lifting lugs or holes.

J. Fan Frame:

1. Construct frame of aluminum or powder-coated steel.

2. Reinforce and brace frame to prevent excessive deflection and pulsation.

3. Include stiffeners to form a rigid frame that is free of structural resonance and vibration.

K. Fan Panel:

1. Construct fan panel of aluminum or powder-coated steel.

2. Reinforce and brace fan panel to prevent excessive deflection and pulsation.

3. Include stiffeners to form a rigid panel that is free of structural resonance and vibration.

L. Fan Inlet Cone:

1. Include a precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of fan blades.

2. Inlet cone shall be a smooth hyperbolic shape.

3. Inlet cone shall be a single piece, constructed of aluminum or powder-coated steel.

4. Fasten inlet cone to fan panel using bolts, nuts, and washers to provide a positive and secure attachment that can be field removable.

M. Fan Wheel:

1. Fan blades shall be a true hollow airfoil shape, welded to backplate and wheel cone.

2. Construct blades of aluminum, reinforced for AMCA fan class.

3. Design blades to provide smooth airflow over all surfaces of blade.

4. Construct fan hubs of aluminum with integral bracing for extra strength and stiffness.

    a. Castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects.

    b. Clean surfaces of castings by blasting, pickling, or any other standard method.

    c. Mold-parting fins and remains of gates and risers shall be chipped, filed, and ground flush.

    d. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance.

5. Hubs shall be keyed and set screwed to motor shaft for positive attachment.

6. Construct wheel backplates of aluminum.

7. Select entire rotating assembly so first critical speed is at least 30 percent greater than fan design speed and at least 20 percent greater than maximum speed in AMCA fan class.

N. Fan Drive:

1. Direct drive, arrangement 4 in accordance with AMCA 99.

2. Adjust wheel width and diameter to match motor speed while providing performance scheduled.

3. Fasten fan wheel directly to motor shaft using a key in motor shaft and setscrew.

4. Construct motor base and pedestal supports of galvanized steel or powder-coated steel.

O. Fan Motors: See "Fan Motors" Article for ac motors.

P. Fan Motors, Electronically Commutated (EC):

1. Description: EC, variable-speed, dc, programmable brushless motor.

2. Features:

    a. Integral controller/inverter operates wound stator and senses rotor position to electronically commutate the stator.

    b. Controller shall control motor speed either through manual adjustment locally at fan array control panel or through a remote 0- to 10-V-dc control signal.

    c. Motor Mounting: Coordinate with driven equipment; suitable for mounting with motor shaft in either horizontal or vertical position.

3. Performance:

a. Altitude: Suitable for operation at site altitude.

b. Electrical Characteristics: Suitable for operation with field power source. Coordinate with electrical Installer.

c. Energy Efficiency: Complying with governing energy codes; 80 percent or higher maintained throughout entire operating range.

d. Power Factor: 0.9 or higher at full load.

e. Service Factor: 1.0 or higher.

f. Speed Control: Variable, zero to 100 percent.

1) Synchronous speed rotation with no slip losses.

2) Gradual ramp-up to set point upon receiving a start signal.

3) Soft speed change ramps.

4) Able to overcome reverse rotation without impact.

5) Control airflow within 5 percent of set point regardless of static pressure.

g. Temperature: Suitable for operation in ambient temperature range encountered.

h. Thermal Protection:

1) Automatically breaks electrical power to motor when temperature exceeds a safe value.

2) Automatically resets and restores power when temperature returns to normal range.

4. Bearings: Sealed and permanently lubricated ball bearings.

5. Enclosure: ODP or TEFC.

6. Insulation: Class B or Class F.

7. Rotor: Permanent magnet with near zero rotor losses that operates independent of motor current.

8. Materials and Construction:

a. Enclosure and Frame: Aluminum, painted steel, or stainless steel.

b. End Brackets: Cast aluminum.

c. Shaft: Steel or stainless steel.

d. Motor Leads: Pin or screw terminals.

e. Nameplates: Manufacturer's standard.

f. Paint: Manufacturer's standard.

Q. Fan Enclosure:

1. Include each fan in fan array with integral single-wall enclosure constructed of solid aluminum or powder-coated steel sheet.

2. Enclosure shall not increase fan array length beyond size indicated on Drawings.

3. Enclosure shall not add static pressure loss.

4. Enclosure shall provide a physical separation between operating adjacent fans to prevent negative performance.

R. Backdraft Damper:

1. Include each fan in the fan array with a backdraft damper at the fan inlet or outlet to prevent air circulation through a fan that is not operating.

2. Open backdraft damper when fan is operating and close when fan is not operating.

3. Design backdraft damper assembly to operate with little to no static pressure loss with fan operating throughout entire operating range from design to minimum airflow.

a. Add damper pressure loss shall to fan scheduled total static pressure.

b. If pressure loss requires a change field electrical power, air-handling unit manufacturer shall be responsible for associated cost of change.

4. Fasten backdraft damper assembly to fan panel or enclosure using hardware designed for easy removal by maintenance personnel.

5. Dampers shall not create measurable additional noise above the sound level of fan.

6. Dampers shall not vibrate or rattle.

7. Construct dampers of extruded aluminum, stainless steel, or powder-coated steel.

S. Blank-off Panels:

1. Include 10 percent of blank-off panel(s) with each air-handling unit fan array for use by operators in the field to prevent air circulation through any of the fans in fan array that are not operating.

2. Design blank-off panels for attachment to fan panels using easily removable and reusable hardware.

3. Construct blank-offs of aluminum, stainless steel, or powder-coated steel sheets, not less than 0.07 inch (1.8 mm) thick.

4. Mount fan blank-off panels in the fan inlet access section for convenient operator access and use in the future.

T. Hardware: Hex-head, high-strength carbon steel with corrosion-resistant coating or 300 series stainless steel.

U. Nameplates:

1. Construct nameplates and rotation arrows of aluminum or 300 series stainless steel.

2. Securely fasten nameplate and rotation arrow to fan housing using pins or sheet metal screws.

3. Locate nameplates in a highly visible location on motor side of fan.

4. Engrave or label the following information on nameplate:

a. Manufacturer, address, phone number, and website address.

b. Manufacturer model number.

c. Serial number.

d. Manufacturing date.

e. Fan size.

f. Fan schedule equipment designation (may be listed on a separate nameplate if there is insufficient space).

g. Design airflow.

h. Design static pressure.

i. Design fan speed.

j. AMCA fan class.

V. Air-Handling Unit Factory Assembly:

1. Internal Access: Include each fan with internal access from downstream and upstream sides as indicated on Drawings.

2. Removal and Replacement: Each fan wheel and motor shall be independently removable and replaceable through a removable access door installed in air-handling unit casing.

3. Stackable Fan Arrays: Construct frame work from aluminum, galvanized steel, or stainless steel.

4. Panel-Mounted Fan Array Supports:

   a. Construct a freestanding and self-supporting structural framework to support each fan individually from and independent of adjacent fans.

   b. Construct frame work from aluminum, galvanized steel, or stainless steel.

2.11 FAN MOTORS

A. Source Limitations: Obtain motors from single source from single manufacturer.

B. Standard: Comply with NEMA MG 1 unless more stringent requirements are indicated.

C. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium-induction motor.

1. Performance:

   a. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

   b. Efficiency: NEMA Premium Efficiency rating complying with NEMA MG 1.

   c. Motor Horsepower: Minimum size as indicated on Drawings. Motor shall operate fan under all conditions indicated without exceeding motor nameplate and without use of motor service factor.

   d. Inverter-Duty Rating: Comply with minimum requirements of Class F or Class H insulation, suitable for "inverter-duty" or "drive-duty" applications in accordance with NEMA MG 1. Motor operation through a variable-frequency controller shall not adversely affect the motor performance, operation, useful life, and warranty.

   e. Service Factor: 1.15.

   f. Temperature Rise: Match insulation rating.

D. Enclosure Type: ODP or TEFC.

E. Shaft Grounding System:

1. Shaft grounding system to protect bearings from induced voltage.

2. Shaft grounding system shall have low drag (less than 0.05 percent of motor horsepower), and shall operate for a minimum of three years without periodic maintenance or adjustments.

3. Mounting: External or internal to motor enclosure.

F. Frame:

1. Frames with integrally cast feet unless other requirements of driven equipment require a different arrangement.

2. Frame, front and back end brackets, and front and back end bearing intercaps constructed of cast iron, ASTM A48/A48M, Class 25 or better.

G. Rotor:

1. Fabricate rotor frame from die-cast aluminum, copper, or associated alloys.

2. Key rotors to motor shaft.

3. Rotating assembly shall be dynamically balanced to within limits defined in NEMA MG 1.

4. Motors shall have the entire rotating assembly between bearing inner caps coated with a corrosion-resistant coating.

H. Stator:

1. Copper windings shall be spike resistant to withstand 1600 peak V.

2. Entire wound and insulated stator coated with a coating to protect against moisture and corrosion.

I. Shaft:

1. Solid shaft fabricated of carbon steel, accurately turned, ground and polished, and inspected for accuracy.

2. End of shaft with drilled hole for use in field measurements.

J. Bearings:

1. Grease-lubricated ball or roller bearings.

2. ABMA 11 L-10 motor bearing life of 100,000 hours.

3. Bearing Lubrication:

a. Factory lubricate motor bearings using a premium moisture-resistant polyurea thickened grease with rust inhibitors suitable for extreme operating temperatures encountered.

b. Coordinate special requirements that may impact lubrication and include appropriate lubrication.

4. Grease Fittings:

a. Equip each bearing housing with an easily accessible grease inlet.

b. Fit grease inlets with a grease fitting and protective fitting cap.

c. Equip inlets with an automatic grease relief fitting to prevent excessive greasing.

d. Equip each bearing housing with grease drain and threaded plug.

K. Conduit Box:

1. Material same as frame.

2. For motor frames 365T and below, furnish conduit boxes sized with internal volumes in accordance with NEMA MG 1.

3. For motor frames larger than 365T, furnish conduit boxes one size larger than NEMA MG 1.

4. Coordinate the location and mounting of conduit box with driven equipment manufacturer.

5. Factory mount conduit box on motor.

L. Grounding: NRTL-listed clamp-type grounding lug mounted in conduit box.

M. Motor Leads:

1. Non-wicking type, Class F temperature rating or better and permanently numbered over entire length for identification.

2. Lead terminals shall be manufacturer's standard.

N. Condensate Drains:

1. Motor with drain holes at the lowest point for drainage of condensate.

2. Each drain hole with a threaded removable plug.

O. TEFC Motor Fans: Corrosion-resistant construction, non-sparking, metallic or non-metallic, bi-directional, and keyed to shaft.

1. Motor Fan Cover: Steel.

P. Hardware: Hex-head, high-strength, zinc-plated carbon steel or stainless steel.

Q. Lifting Eyebolts: Eyebolt threaded into frame receptacle and design to prevent moisture and other foreign material from entering motor cavity when eyebolt is removed.

R. Nameplates:

1. Construct nameplates of aluminum or stainless steel and attach to motor frame with aluminum, stainless steel, or brass drive pins.

2. Engrave or stamp data on the nameplate.

3. At a minimum, include nameplate data in accordance with NEMA MG 1.

S. Paint: Successfully pass 500-hour salt spray test for corrosion in accordance with ASTM B117.

2.12 VIBRATION ISOLATION

A. General:

1. Provide fans inside air-handling units with base and vibration isolation indicated on Drawings.

B. Inertia Bases:

1. Description: Reinforced structural base designed for concrete infill with integral bolting provisions for fan mounting.

2. Design and Performance:

a. Weight of inertia base including concrete infill a minimum of 1.5 times the operating weight of fan.

b. Base thickness not less than 1/12 of longest span.

c. Minimum base thickness is as follows:

1) Up to 15 HP (11 kW): 6 inches (150 mm).

2) 20 to 50 HP (15 to 37 kW): 8 inches (200 mm).
3) 60 to 75 HP (45 to 56 kW): 10 inches (250 mm).

4) 100 HP (75 kW) and Larger: 12 inches (300 mm)

3. Construction:

a. Base Materials: structural stainless steel, ASTM A276/A276M, Type 304L or structural stainless steel, ASTM A276/A276M, Type 316L.

a. Base Structural Members:

1) Perimeter Members: Channel I or W beam shapes or tube.

2) Intermediate Members (Spanning Full-Width Base): Channel or I or W beam shapes or tube.

3) Cross Members (Spanning Intermediate Members): channel or tube.

b. Reinforcing Bars: Carbon steel, ASTM A615/A615M, sized for a maximum stress of 20,000 psi (138 000 kPa) when subjected to both static and dynamic loads, and welded in place.

c. Floor: Design inertia base with solid floor in bottom for concrete placement after base installation. Seal to prevent leakage or seepage.

1) Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 (Z275) coating, minimum (nominal) 18 gauge (1.3 mm) thick.

2) Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M; Type 304L; No. 2D finish; minimum (nominal) 18 gauge (1.3 mm) thick.

d. Isolator Brackets: Gusseted, height-saving brackets.

e. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.

4. Air-Handling Unit Factory Assembly: Install fans with inertia bases where indicated on Drawings.

a. Coordinate placement of inertia bases with design of air-handling unit structural base. Make provisions for attachment and support.

b. Coordinate inertia base mounting provisions with spring isolators.

C. Spring Isolators:

1. Performance:

a. Deflection: Minimum deflection indicated on Drawings. Use a greater deflection if required to maintain an isolator efficiency of at least 98 percent under all operating conditions encountered. Calculate isolator efficiency using actual support conditions considering the rigidity of structure.

b. Laterally stable freestanding open-spring mounting.

c. Spring diameter not less than 0.8 of compressed spring height at rated load and in the installed and operating condition.

d. Reserve travel to solid shall be equal to a minimum of 50 percent of rated deflection and in no case less than 25 percent of rated deflection in an installed and operating condition.

e. Ratio of horizontal stiffness to vertical stiffness equal to approximately one.

f. Design and install so that ends of springs remain parallel.

g. Select springs that are non-resonant with equipment related frequencies and natural frequencies of support structure.

h. Springs shall not take a permanent set when compressed to coil bind.

2. Construction:

a. Coat springs with PVC or neoprene. Color-code springs to allow positive identification after installation.

b. Construct baseplates, spring retainers, and other components of aluminum galvanized carbon steel or stainless steel. Etch and paint aluminum components.

c. Use nuts, bolts, and washers and other associated hardware constructed of zinc-electroplated carbon steel or stainless steel.

d. Isolators with integral leveling bolts.

e. Baseplates with holes and isolation grommets for bolting.

f. Bond nominal 1/4-inch- (6-mm-) thick, neoprene friction pad to baseplate.

D. Thrust Restraints:

1. In sets of two or more, thrust restraints shall consist of springs in series with neoprene isolators.

2. Coordinate and select deflection of thrust restrains with equipment being restrained.

3. Thrust restraints complete with rods and adjustment nuts, plus angle brackets and backing plates for attachment to substrate and equipment being restrained.

E. Elastomeric Grommets:

1. Elastomeric grommets shall be a combination of neoprene washer and bushing.

2. Elastomer shall be 56-durometer maximum.

3. Grommets formed to prevent bolts from directly contacting the secured item.

F. Flexible Connections:

1. Construct flexible connection galvanized-steel edges firmly attached to waterproof and fire-retardant fabric.

2. Fabric shall be 6 inches (150 mm) wide or more.

3. Suitable for operation in extreme temperatures encountered.

4. NRTL listed for application and complying with NFPA 90A.

G. Air-Handling Unit Factory Assembly:

1. Use precompression -type height-saving brackets with isolators having 2-1/2 inch (65-mm) deflection or greater, to limit exposed bolt length.

2. Install spring isolators plumb and adjust isolators that are not plumb under operating conditions to make plumb.

3. Adjust isolators to prevent stress transfer to equipment.

4. Verify that installed isolators and mounting systems permit equipment motion in all directions.

5. Restraint fans with isolated thrust resistors to limit displacement to 1/4 inch (6 mm). Design for the maximum lateral thrust the fan can develop.

6. Adjust or include additional resilient restraints to flexibly limit fan lateral motion to 1/4 inch (6 mm)during startup and operation of equipment.

7. Anchor restraints to fixed supports having a stiffness greater than the thrust encountered.

8. Include at least 2-inch (50-mm) operating clearance between fan bases and walking surface of air-handling unit floor. Before startup, clean out foreign matter between bases and equipment to prevent short circuit.

9. Flexible Connections:

   a. Install flexible connections at connections to fans.

   b. Install flexible connections in accordance with SMACNA standards and manufacturer's written instructions.

   c. Make fabric joints on the flat run, not the corners, with overlap to provide an area sufficient to make a positive seal.

   d. Apply adhesive between fabric layers.

   e. Attach connections using screws or bolts.

   f. Reinforce fabric if required to keep fabric from collapsing and impacting airflow into fan.

2.13 HYDRONIC COILS

A. Sourcing Option: In lieu of sourcing hydronic coils from a specialty coil manufacturer, air-handling unit manufacturer has option to furnish in-house hydronic coils that achieve equal or better performance while complying with other requirements indicated.

B. General: Provide air-handling units with hydronic coils where indicated on Drawings.

C. Description: Plate fin coils constructed of staggered tubes mechanically expanded into continuous collars that are die formed into plate fins.

D. Design and Performance:

1. Capacities, face area, and number of rows indicated on Drawings are minimum acceptable.

2. Air pressure drop, water pressure drop, fin spacing, and face velocity indicated on Drawings are the maximum acceptable.

3. Coils shall be counterflow design, air to fluid. Fluid supply shall enter air leaving side of coil and exit air entering side.

4. Design coils to be drainable.

   a. Coils shall have all circuits drainable when coils are installed in horizontal position and level.

   b. Coil supply and return header shall be furnished with a drain connection at lowest point on header.

5. Design coils to be self-venting.

   a. Supply connection near bottom of supply header.

   b. Return connection near top of return header.

   c. Furnish coil return and supply header with a vent connection at highest point on header.

6. Coils supply and return piping connections on same end of coil.

7. Coils shall be rated for system operating pressures and temperatures encountered by installation, but not less than 200 psig (1379 kPa).

8. Coil selection criteria, unless otherwise indicated on Drawings, are as follows:

   a. Face Velocity: Maximum of 500 fpm (2.5 m/s).

   b. Fluid Tube Velocity (at Design Flow Rate):

1) Maximum: 6 fps (1.8 m/s).

2) Minimum: 3 fps (0.9 m/s).

c. Fluid Header Velocity: Maximum of 6 fps (1.8 m/s).

d. Fin Height: Maximum of 48 inches (1200 mm).

e. Fin Spacing: Maximum of 12 fins per inch (2.1 mm).

9. Cooling coils shall have no moisture carryover at design conditions. Install moisture eliminators on discharge face of coil if it is necessary to eliminate moisture carryover.

E. Casing and Tube Sheets:

1. Depth: Extend coil casing and tube sheets a minimum of 1/2 inch (13 mm) beyond face of fins on both entering and leaving side.

2. Casing and Tube Sheet Materials:

a. Cooling Coils: Stainless steel, ASTM A240/A240M or ASTM A480/A480M, Type 304L or Type 316L, No. 2D finish.

b. Heating Coils:

1) Stainless steel, ASTM A240/A240M or ASTM A480/A480M, Type 304L or Type 316L, No. 2D finish.

2) Galvanized steel, ASTM A653/A653M, G90 (Z275) coating.

3. Top and Bottom Casings:

a. Flange face minimum of 1-1/2 inches (68 mm); double flange edge for rigidity and ease of removal with secondary flange face minimum of 1/2 inch (13 mm).

b. Thickness:

1) Coils with Fin Length of up to 72 Inches (1800 mm): Minimum of 16 gauge (1.6 mm) thick.

2) Coils with Fin Length Exceeding 72 Inches (1800 mm): Minimum of 16 gauge (1.6 mm) thick.

4. End Tube Sheets:

a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.

b. Flange face minimum of 1-1/2 inches (68 mm).

c. Thickness: Minimum of 16 gauge (1.6 mm) thick.

5. Intermediate Tube Sheets:

a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.

b. Space intermediate tube sheets a maximum of 48 inches (1200 mm) o.c. and locate to provide equal spacing between tube sheet across coil tube length.

c. Flange face minimum of 1/2 inch (13 mm).

d. Thickness: Minimum of 16 gauge (1.6 mm) thick.

6. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

F. Fins:

1. Materials:

a. Aluminum: 0.0060 inch (0.15 mm), 0.0095 inch (0.24 mm) thick.

2. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.

3. Fin Configuration: Flat face or enhanced ripple fins as required by performance.

G. Headers:

1. Construct header of seamless copper, ASTM B75/B75M drawn temper of diameter and wall thickness based on coil size, flow rate, design pressure, design temperature, and circuiting.

2. Tube-to Header Connections: Tube-to-header holes shall intrude inward so landed surface area is three times the core tube thickness, to provide enhanced header to tube joint integrity. Tubes shall evenly extend within the ID of the header no more than 0.12 inch (3 mm).

3. Header Top and Bottom Caps: End caps shall be die-formed and installed on the ID of header such that the landed surface area is three times the header wall thickness.

4. Drains: Include low point of supply and return header with a NPS 1/2 (DN 13) Insert pipe size drain connection. Extend copper or red brass pipe through air-handling unit casing and terminate end with male national pipe threads (MNPT). Pipe shall be threaded on both ends to facilitate easy field removal and replacement.

5. Vents: Include high point of supply and return header with a NPS 1/2 (DN 13) vent connection. Extend copper or red brass pipe through air-handling unit casing and

terminate end with MNPT. Pipe shall be threaded on both ends to facilitate easy field removal and replacement.

6. Supply and Return Connections:

   a. Terminate ends with MNPT.

   b. Connections to header shall be either copper tube with brazed ASME B16.18 threaded male adapters or red brass pipe with machine-threaded MNPT connections. Pipe shall extend through air-handling unit casing and be threaded on both ends to facilitate easy field removal and replacement.

   c. Connections NPS 2-1/2 (DN 65) and larger shall have a bronze ASME 16.24 threaded flanges attached to threaded connections to provide for a flanged field connection. Select flange class, Class 150 or Class 300, for system pressure and temperature encountered.

7. Protect openings of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into the coil.

H. Tubes:

1. Material: Copper, ASTM B75/B75M annealed temper or ASTM B280 drawn temper;.

2. Tube Nominal Diameter: 1/2 or 5/8 inch (13 or 16 mm) before expanding, selected to provide performance indicated.

3. Tube Nominal Wall Thickness: As required by performance, minimum of 0.020 inch (0.5 mm) and 0.035 inch (0.9 mm) thick.

I. Tube Return Bends: 180-degree bends brazed to tubes; material, wall thickness, and nominal diameter to match tubes.

1. Tube Return Bend Nominal Wall Thickness: As required by performance, minimum of 0.020 inch (0.5 mm) 0.035 inch (0.9 mm) thick.

J. Brazing: High-temperature brazing alloy with not less than 5 percent silver when brazing like non-ferrous materials together and more than 30 percent silver when brazing ferrous to non-ferrous materials.

K. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 304 or Type 316 stainless steel.

L. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.

2. Manufacturer model number.

3. Serial number.

4. Manufacturing date.

5. Coil identification (indicated on Drawings).

6. Coil fin length.

7. Coil fin height.

8. Coil weight with fluid/without fluid.

9. Coil casing material and thickness.

10. Coil fin material and thickness.

11. Coil tube material and thickness.

12. Coil header material and thickness.

M. Cleaning: Residual manufacturing oils and solid contaminants shall be removed internally and externally by completely submersing the coil in an environmentally acceptable degreasing solution that is chemically compatible with the coil material.

N. Air-Handling Unit Factory Assembly:

1. Coil Connections: Extend each coil connection through casing access panel and terminate connections, approximately 4 inches (100 mm) beyond exterior face of access panel, and seal each penetration as indicated. Casing access panels shall be removed and reinstalled with coils installed inside air-handling units.

2. Internal Access: Include each coil with internal access from downstream and upstream sides as indicated on Drawings.

3. Removal and Replacement: Each coil shall be independently removable and replaceable through a removable access panel installed in air-handling unit casing.

4. Supports for Coils:

a. Construct a freestanding and self-supporting structural framework to support each coil individually from and independent of adjacent coils.

b. Construct framework for cooling coils, from aluminum or stainless steel structural shapes.

c. Construct frame work for heating coils from aluminum, galvanized steel, or stainless steel structural shapes.

2.14 HEATING COILS WITH INTEGRAL FACE-AND-BYPASS DAMPERS

A. Source Limitations: Obtain coils from single source from single manufacturer.

B. General: Provide air-handling units with heating coils with integral face-and-bypass dampers where indicated on Drawings.

C. Description: Horizontal or vertical tube arrangement as indicated on Drawings with integral face-and-bypass dampers and controls installed to control modulating dampers to achieve discharge air temperature set point.

1. Each coil consisting of multiple finned heating elements, each with bypasses and interlocking dampers controlled by electric actuators and a discharge airstream thermostat.

D. Performance:

1. Each coil able to maintain constant discharge air temperature regardless of variations in entering-air temperature with constant water flow through coil.

2. Portioning of air across and around the heating element shall result in a uniform temperature within 5 deg F (3 deg C) of average temperature when measured anywhere across a vertical plane located 24 inches (600 mm) downstream of leaving face of coil.

E. Casing: Galvanized steel or Type 304 stainless steel, minimum of 16 gauge (1.6 mm) thick. Standard casing shall be extended if required air-handling unit manufacturer to accommodate installation arrangement inside of the air-handling unit.

F. Fins: Rectangular shape, constructed of 0.010-inch- (0.25-mm-) thick aluminum with spacing not closer than 12 fins per inch (2.1 mm).

G. Headers: copper, of thickness selected by manufacturer for flow, pressure, and temperature encountered; drain connections at low points, vent connections at high points, and supply and return connections located on discharge face of coil.

1. Insulation: Insulate headers with mineral-fiber insulation covered by a metal jacket.

2. Supply and Return Connections:

a. Terminate ends with MNPT.

b. Connections NPS 2-1/2 (DN 65) and larger shall have thread-on flanges. Select flange class, Class 150 or Class 300, for system pressure and temperature encountered.

H. Tubes:

1. Materials: Copper.

2. Nominal Diameter: 5/8 inch (16 mm).

3. Nominal Tube Wall Thickness: As required by performance, minimum of 0.035 inch (0.9 mm) thick.

I. Dampers: Clamshell design arranged to modulate airflow across or around individual heating elements. Constructed of galvanized steel or Type 304 stainless steel, minimum of 16 gauge (1.6 mm) thick.

J. Damper Actuators: Face or side mounted; electric motor for proportional control, failing in last position.

K. Brazing: High-temperature brazing alloy with not less than 5 percent silver when brazing like non-ferrous materials together and more than 30 percent silver when brazing ferrous to non-ferrous materials.

L. Coating: Where indicated on Drawings, coat coil casings and damper assemblies with air-dried alkyd enamel corrosion-resistant coating.

M. Hardware: Use hex-head bolts, nuts, and washers constructed of zinc-plated carbon steel or Type 304 stainless steel.

N. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.

2. Manufacturer model number.

3. Serial number.

4. Manufacturing date.

O. Air-Handling Unit Factory Assembly:

1. Coil Connections: Extend each coil connection through casing access panel and terminate connections, approximately 4 inches (100 mm) beyond exterior face of the access panel as seal each penetration as indicated. Casing access panels shall be removed and reinstalled with coils installed inside air-handling units.

2. Internal Access: Include each coil with internal access from downstream and upstream sides as indicated on Drawings.

3. Removal and Replacement: Each coil shall be independently removable and replaceable through a removable access panel installed in air-handling unit casing.

4. Supports for Coils:

a. Construct a freestanding and self-supporting structural framework to support each coil individually from and independent of adjacent coils.

b. Construct frame work from aluminum, galvanized steel, or stainless steel structural shapes.

2.15 DRAIN PANS

A. General:

1. Include a drain pan for each cooling coil and at other locations indicated.

2. Continuously weld drain pan seams, joints, and mitered corners to make the assembled drain pan watertight.

3. Drain pans shall be located under the entire coil and provide full coil coverage including coil return bends and headers.

4. Slope drain pans in multiple directions toward low point drain connection at a uniform slope of at least 2 percent from high point to low point.

5. Include stainless steel blank-offs to prevent air from bypassing around coil.

B. Bottom Drain Pans:

1. Mounting Location, Recessed in Floor: Air-handling unit manufacturer has option to recess bottom drain pan into the floor or install drain pan above air-handling unit floor walking surface.

2. Grating: Install removable stainless steel grating on top of drain pan.

3. Double-Wall Construction: Double-wall sheet with space between walls filled with 1-inch (25-mm) insulation.

4. Material: Type 304L stainless steel ASTM A240/A240M or ASTM A480/A480M, a minimum of 16 gauge (1.6 mm) thick.

5. Minimum Depth: 1.5 inches (38 mm).

6. Extend drain pan beyond air entering face of coil casing at least 3 inches (75 mm).

7. Extend drain pan beyond air leaving face of coil casing at least 12 inches (150 mm).

   a. Where moisture eliminators are required to prevent moisture carryover, extend drain pan beyond leaving face of moisture eliminator in lieu of the leaving face of coil.

8. Drain Pan Connection:

   a. Stainless steel threaded half-coupling welded to lowest point of drain pan.

   b. Location: Both ends.

c. Minimum Nominal Connection Size: NPS 1.5 (DN 40).

9. Drain Pipe:

a. Air-handling unit manufacturer to connect full size drain pipe to each drain pan connection. Option to use one of following pipe materials:

1) Copper tube with threaded male adapter, brazed or soldered to ends.

1) Aluminum pipe with threaded MNPT ends.

2) Stainless steel pipe with threaded MNPT ends.

b. Extend drain pipe and terminate 3 inches (75 mm) beyond exterior face of casing.

2.16 PLEATED PANEL FILTERS

A. Source Limitations: Obtain filters from single source from single manufacturer.

B. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters.

C. Performance:

1. Filtration Efficiency, ASHRAE 52.2 MERV Rating: 8.

2. Energy Cost Index: Five star rating.

3. Initial Air Pressure Drop: With face velocity of 500 fpm (2.5 m/s), clean filter pressure drop shall not exceed the following:

a. MERV 8 and MERV 8A:

1) Depth 2 Inches (50 mm): 0.31 inch wg (78 Pa).

4. Manufacturer-Recommended Final Air Pressure Drop: 1.0 inch wg (250 Pa).

5. Pressure Differential without Failure: 2 inches wg (500 Pa).

6. Temperature Rating: 200 deg F (93 deg C).

D. Certification:

1. AHRI: Tolerances in accordance with AHRI 850 (I-P) and AHRI 851 (SI).

2. ASHRAE: Tested and rated in accordance with ASHRAE 52.2.

3. UL: UL 900 listed.

E. Size:

1. Nominal Filter Size:

   a. Face: 20 by 24 inches (600 by 600 mm).

   b. Depth: 2 inches (50 mm).

2. Actual Filter Size: Suitable for installation in an industry-standard filter holding frame.

F. Filter Media Surface Area: Each filter shall contain the following minimum media surface area for a filter with a nominal 24-by-24-inch (600-by-600-mm) face:

1. Depth 2 Inches (50 mm): 17.3 sq. ft. (1.6 sq. m).

G. Construction:

1. Media: Glass or Cotton and synthetic blend of fibers arranged in a series of pleats attached to and supported by a corrosion-resistant welded-wire grid.

2. Filter Media Casing: High wet strength (28-point) beverage board that is bonded around the periphery to eliminate air bypass.

   a. Diagonal support members across upstream and downstream filter face constructed of same material as casing shall ensure pleat spacing and stability.

3. Adhesive: Fire-retardant bonding adhesive where bonding media to casing.

2.17 ASHRAE-RATED FILTER HOLDING FRAMES

A. Filter Holding Frames for ASHRAE-Rated Filters:

1. Fabricate filter holding frames with mitered corners and reinforce frame to maintain a durable, rugged, true square shape.

2. Construct frames of galvanized or stainless steel. Use stainless steel frames in applications exposed to corrosive airstreams.

3. For applications with pre-filter and final filters sharing the same filter holding frame, frames shall be suitable for supporting and holding both pre-filter and final filters in frame with both filters serviceable from upstream (entering air) side.

4. Frame Depth: At least 2.75 inches (70 mm).

5. Gaskets: Continuous, suitable for same operating temperature as filters.

6. Filter Clips: Each filter holding frame with spring clip fasteners at each corner. Spring clips shall allow filters to be removed and replaced without use of tools.

7. Frames shall be industry-standard size to provide interchangeability of filters from other manufacturers.

B. Air-Handling Unit Factory Installation:

1. Air-handling unit manufacturer shall furnish filters and provide filter holding frames, retaining clips, and filter support structures.

2. Furnish filter quantity, size, type, and performance indicated on Drawings.

3. Install filter frames in a flat vertical position for horizontal airflow.

4. Install holding frames in accordance with manufacturer's written instructions and to prevent passage of unfiltered air. Include additional gaskets as necessary.

5. Secure individual holding frames together to build a multiple filter bank.

6. Construct aluminum galvanized-steel or stainless steel support structure to hold frames and filters.

a. Design support structure for maximum system operating pressures encountered equal to fan shutoff pressure.

b. Design and fabricate support structure to limit deflection across filter bank to 1/360 of the span when subjected to a 200-lb (890-N) lateral force applied at any point on the filter holding frame assembly.

2.18 ABSOLUTE FILTERS

A. Source Limitations: Obtain filters from single source from single manufacturer.

B. Description: Factory-fabricated, disposable, packaged high-efficiency particulate air filters consisting of an anodized aluminum hold frame with media formed into mini-pleats and arranged in a V-shape pattern.

C. Performance:

1. Filtration Efficiency:

a. Rating indicated on Drawings.

b. IEST Rating at 0.3-micron Size: 99.99 percent.

2. Energy Cost Index: Five star rating.

3. Initial Air Pressure Drop: With face velocity of 500-fpm (2.5-m/s), clean filter pressure drop shall not exceed the following:

a. Gasket Seal Filters:

1) 99.99 Percent Efficiency: 1.0 inch wg (250 Pa).

b. Gel Seal Filters:

1) 99.99 Percent Efficiency: 0.9 inch wg (225 Pa).

4. Manufacturer-Recommended Final Air Pressure Drop: 2.0 inches wg (500 Pa).

5. Pressure Differential without Failure: 10 inches wg (2500 Pa).

6. Temperature Rating:

a. Gasket Seal: 175 deg F (79 deg C).

b. Gel Seal: 155 deg F (68 deg C).

D. Certification:

1. IEST: Tested and rated in accordance with IEST's "Recommended Practice for Testing HEPA Filters."

a. Comply with IEST-RP-CC001.6.

b. Comply with IEST-RP-CC034.

2. UL: UL 900 listed.

E. Size:

1. Nominal Face Size: 24 by 24 inches (600 by 600 mm).

2. Depth: 12 inches (300 mm).

3. Actual Filter Size: Suitable for installation in an industry-standard filter holding frame.

F. Filter Media Surface Area: Each filter shall contain the following minimum media surface area for a filter with a nominal 24-by-24-inch (600-by-600-mm) face:

1. Gasket Seal:

a. 99.99 Percent Efficiency: 390 sq. ft. (36.2 sq. m).

2. Gel Seal:

a. 99.99 Percent Efficiency: 401 sq. ft. (37.2 sq. m).

G. Construction for Gasket Seal Filters:

1. Media: Microfine glass media formed into mini-pleats and arranged in a V-shape pattern.

a. Internal Separators: None.

b. Media to Filter Frame Seal Material: Polyurethane.

c. Faceguard Material: Aluminum.

d. Faceguard Location: upstream.

2. Media-Holding Frame: Anodized aluminum enclosing frame with continuous seamless perimeter neoprene gasket.

a. Filter Frame to Mounting Frame Seal Location: Upstream.

3. Adhesive: Fire-retardant bonding adhesive where bonding media to frame.

H. Construction for Gel Seal Filters:

1. Media: Microfine glass media formed into mini-pleats and arranged in a V-shape pattern.

a. Internal Separators: None.

b. Media to Filter Frame Seal Material: Polyurethane.

c. Faceguard Material: Aluminum.

d. Faceguard Location: upstream and downstream.

2. Media-Holding Frame: Anodized aluminum enclosing frame with gel seal track and elastic silicone gel sealant.

3. Adhesive: Fire-retardant bonding adhesive where bonding media to frame.

2.19 ABSOLUTE FILTER HOLDING FRAME ASSEMBLY

A. Source Limitations: Obtain holding frame assembly from absolute filter manufacturer.

B. Description: Holding frame assembly with access for upstream (front) or downstream (back) filter servicing as indicated, specifically designed for absolute filter banks.

1. Gasket Seal: Positive-sealing device to ensure seal between each gasket filter to prevent bypass of unfiltered air. Filter latching mechanism to seat each filter firmly against holding frame surface.

2. Gel Seal: Knife-edge to mate to each filter to prevent bypass of unfiltered air. Positive-locking mechanism for each filter to seat the knife edge into the gel during installation and to remove the filter from the knife edge during filter replacement.

C. Construction:

1. Each filter bank with a factory-assembled filter holding framework consisting of a framework superstructure, a base, bracing, and removable swing bolt assemblies designed to accommodate the scheduled sizes and configuration of absolute filters.

2. Framework:

    a. Nominal 4 inches (100 mm), minimum 11-gauge- (3.1-mm-) thick, galvanized-steel or stainless steel channels or tube.

    b. Continuously weld members. After assembly, grind and polish welds to provide a smooth uniform sealing surface.

3. Base:

    a. Continuously weld the framework to a minimum 11-gauge- (3.1-mm-) thick, galvanized-steel or stainless steel base.

4. Filter Attachment:

    a. Equip framework with four swing bolts for each filter.

    b. Include each swing bolt with a bearing clamp and hex nut designed for applying a sufficiently uniform sealing pressure against the periphery of each filter.

    c. Swing bolts shall be constructed of at least 5/16-inch (8-mm) galvanized or stainless steel.

    d. Hex nuts shall be capable of being torqued to provide at least 50 percent gasket compression.

    e. Swing bolt assembly shall provide individual sealing of filters.

5. Pre-Filter Frames:

    a. For filter banks with pre-filters attached on the air entering side of absolute filter, include an ASHRAE-rated filter holding frame.

    b. Pre-filter holding frames shall be held in place by swing bolts and allow for installation and removal of pre-filters without disturbing absolute filter seal.

D. Air-Handling Unit Factory Installation:

1. Air-handling unit manufacturer shall furnish filters and provide filter holding frames, retaining clips, and filter support structures.

2. Furnish filter quantity, size, type, and performance indicated on Drawings.

3. Install filter frames in a flat vertical position for horizontal airflow.

4. Install holding frames in accordance with manufacturer's written instructions and to prevent passage of unfiltered air. Include additional gaskets as necessary.

5. Construct aluminum, galvanized-steel, or stainless steel support structure to hold frames and filters.

a. Design support structure for maximum system operating pressures encountered equal to fan shutoff pressure.

b. Design and fabricate support structure to limit deflection across filter bank to 1/360 of the span when subjected to a 400-lb (1780-N) lateral force applied at any point on the filter holding frame assembly.

2.20 FILTER GAUGES

A. Provide a gauge to indicate pressure differential between entering and leaving side of each filter bank. Panel filter bank separate from cartridge filter bank.

1. Where multiple filters share a common frame, include a separate gauge for each filter bank.

2. Include a metal spacer constructed of same material as filter frame for one of the filters installed in filter bank to accommodate pressure differential measure across both upstream and downstream filters.

B. Gauge shall have a nominal 4-inch- (100-mm-) diameter face.

C. Select range of gauge to be approximately twice the dirty filter pressure drop.

D. Provide each gauge with vent valves to allow for re-zeroing the gauge without removing tubing connections.

E. Include static pressure sensors on entering and leaving side of each filter bank.

F. Air-Handling Unit Factory Assembly:

1. Mount each filter gauge on exterior surface of unit casing near associated filter sections.

2. Mount center of gauges 60 inches (1500 mm) above bottom of air-handling unit structural base.

3. Connect static pressure sensors to filter gauges using aluminum or stainless steel tubing and compression type fittings.

4. Support tubing at intervals not greater than 60 inches (1500 mm) o.c.

2.21 AUTOMATIC DAMPERS

A. General: Provide air-handling units with automatic dampers where indicated on Drawings.

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, for equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.

2. Factory assemble multiple damper sections to provide a single damper assembly of size required by application.

3. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.

B. Rectangular Dampers with Aluminum Blades:

1. Source Limitations: Obtain dampers from single source from single manufacturer.

2. Performance:

a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.

b. Pressure Drop: 0.05 inch wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, figure 5.3.

c. Velocity: Up to 4000 fpm (20 m/s).

d. Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

f. Damper shall have AMCA seal for both air leakage and air performance.

3. Construction:

a. Frame:

1) Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.

2) Hat-shaped channel with integral flange(s). Flange mating face shall be a minimum of 1 inch (25 mm).

3) Width not less than 5 inches (125 mm).

b. Blades:

1) Hollow, airfoil, extruded aluminum.

2) Parallel- or opposed-blade configuration as required by application.

3) Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch (1.8 mm) thick.

4) Width not to exceed 6 inches (150 mm).

5) Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

c. Seals:

1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.

2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch- (13-mm-) diameter plated or stainless steel, mechanically attached to blades.

e. Bearings:

1) Molded synthetic or stainless steel sleeve mounted in frame.

2) Where blade axles are installed in vertical position, include thrust bearings.

f. Linkage:

1) Concealed in frame.

2) Constructed of aluminum and plated or stainless steel.

3) Hardware: Stainless steel.

4. Airflow Control: Where indicated, provide damper assembly with integral airflow measurement and control.

a. Source Limitations: Obtain damper assembly from single source from single manufacturer.

b. A factory-furnished and -calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.

c. Controller and actuator shall communicate to control the desired airflow.

d. Controller shall receive a 0- to 10-V dc input signal and report a 0- to 20-mA output signal that is proportional to airflow.

e. Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm (0.8 to 10 m/s).

f. Ambient Operating Temperature Range: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).

g. Ambient Operating Humidity Range: 5 to 95 percent relative humidity, noncondensing.

h. Provide unit with control transformer rated for not less than 85 VA. Include transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.

i. Include screw terminals for interface to field wiring.

j. Factory mount electronics within a NEMA 250, Type 1 painted steel enclosure.

C. Damper Actuators:

1. General:

a. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which damper is subjected.

b. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.

c. Total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.

d. Include one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.

e. Avoid use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

f. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

g. Include mounting hardware and linkages for connecting actuator to damper.

h. Select actuators to fail in desired position in the event of a power failure.

i. Actuator Fail Positions: As indicated below:

1) Exhaust Air: Close.

2) Outdoor Air: Close.

3) Supply Air: Open.

2. Type: Motor operated, with or without gears, electric and electronic.

3. Voltage:

a. 24V.

b. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

c. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

4. Construction:

a. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

b. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.

c. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

5. Field Adjustment:

a. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.

b. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when actuator is not powered.

6. Two-Position Actuators: Single direction, spring return, or reversing type.

7. Modulating Actuators:

a. Capable of stopping at all points across full range, and starting in either direction from any point in range.

b. Control Input Signal:

1) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0- to 10-V dc signals.

2) Pulse-Width Modulation (PWM): Actuator drives to a specified position in accordance with a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.

Retaining "Programmable Multifunction" Subparagraph below limits manufacturer choices. Belimo Americas (USA) is most well-known manufacturer offering product.

3) Programmable Multifunction:

a) Control input, position feedback, and running time shall be factory or field programmable.

b) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
c) Service data, including at a minimum, number of hours powered, and number of hours in motion.

8. Position Feedback:

Retain one of first two subparagraphs below to include a signal for remote monitoring of position through positive means. Remote monitoring requires additional control inputs. Coordinate requirements with interface to control system.

a. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.

b. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

c. Include a position indicator and graduated scale on each actuator indicating open and closed travel limits.

9. Fail-Safe:

a. Where indicated, provide actuator to fail to an end position.

b. Internal spring return mechanism to drive-controlled device to an end position (open or close) on loss of power.

c. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

10. Integral Overload Protection:

a. Provide against overload throughout the entire operating range in both directions.

b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

11. Damper Attachment:

a. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.

b. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.

c. Bolt and setscrew method of attachment is acceptable only if included with at least two points of attachment.

12. Temperature and Humidity:

a. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F (minus 29 to plus 49 deg C).

b. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, noncondensing.

13. Enclosure:

a. Suitable for ambient conditions encountered by application.

b. Provide actuator enclosure with a heater and controller where required by application.

c. NEMA 250, Type 2.

d. NEMA 250, Type 4 or Type 4X.

14. Stroke Time: Select operating speed to be compatible with equipment and system operation.

Retain any of first three subparagraphs below to dictate operating performance.

a. Operate damper from fully closed to fully open within 15 seconds.

b. Operate damper from fully open to fully closed within 15 seconds.

c. Move damper to failed position within 5 seconds.

d. Actuators operating in smoke-control systems shall comply with governing code and NFPA requirements.

15. Sound:

a. Spring Return: 62 dBA.

b. Non-Spring Return: 45 dBA.

2.22 MANUAL BALANCING DAMPERS

A. General: Air-handling unit manufacturer shall furnish and factory install manual balancing dampers inside air-handling units where indicated on Drawings.

B. Rectangular Manual Balancing Dampers with Aluminum Airfoil Blades:

1. Source Limitations: Obtain dampers from single source from single manufacturer.

Requirements in "Performance" and "Construction" subparagraphs below are based on Ruskin's "CD50 Series."

2. Performance:

   a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.

   b. Pressure Drop: 0.05 inch wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, figure 5.3.

   c. Velocity: Up to 6000 fpm (30 m/s).

   d. Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

   e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

   f. Damper shall have AMCA seal for both air leakage and air performance.

3. Construction:

   a. Frame:

      1) Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.

      2) Hat-shaped channel with integral flange(s). Flange mating face shall be a minimum of 1 inch (25 mm).

      3) Width not less than 5 inches (125 mm).

   b. Blades:

      1) Hollow, airfoil, extruded aluminum.

      2) Parallel- or opposed-blade configuration as required by application.

      3) Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch (1.8 mm) thick.

      4) Width not to exceed 6 inches (150 mm).

      5) Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

   c. Seals:

      1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.

      2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch- (13-mm-) diameter plated or stainless steel, mechanically attached to blades.

e. Bearings:

1) Molded synthetic or stainless steel sleeve mounted in frame.

2) Where blade axles are installed in vertical position, include thrust bearings.

f. Linkage:

1) Concealed in frame.

2) Constructed of aluminum and plated or stainless] steel.

3) Hardware: Stainless steel.

g. Locking Regulator:

1) Aluminum or stainless steel standoff with locking regulator mounted to frame in an accessible location for manual adjustment of damper blades.

Retain "Additional Corrosion Protection for Corrosive Environments" Subparagraph below for applications requiring additional protection against corrosion.

h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch (0.018 mm) thick.

2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

Retain "Industrial-Duty Manual Balancing Dampers with Airfoil Blades" Paragraph below to include galvanized-steel or stainless steel airfoil blade dampers in applications where aluminum blade dampers cannot satisfy the requirements. Retain stainless steel for better resistance to corrosion.

2.23 SMOKE DAMPERS

Retain "Smoke Detectors" Article to include smoke dampers in air-handling units.

A. General: Air-handling unit manufacturer shall furnish and factory install smoke dampers inside air-handling units where indicated on Drawings.

B. Rectangular Smoke Dampers with Galvanized-Steel Blades:

1. Source Limitations: Obtain dampers from single source from single manufacturer.

2. General: Air-handling unit manufacturer shall furnish and factory install smoke dampers inside air-handling units where indicated on Drawings.

3. Performance:

    a. Leakage: In accordance with UL 555S, Class 1.

    b. Pressure Drop: 0.07 inch wg (17.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, figure 5.3.

    c. Velocity: Up to 4000 fpm (20 m/s).

    d. Temperature: 250 deg F (121 deg C).

    e. Pressure Rating: 8.0 inches wg (2000 Pa).

4. Certification: NRTL listed and labeled in accordance with UL 555S, Class 1.

5. Construction:

    a. Frame:

        1) Material: Galvanized steel, minimum 0.06 inch (1.6 mm) thick.

        2) Hat-shaped channel with integral flange(s). Flange mating face shall be a minimum of 1 inch (25 mm).

        3) Width not less than 5 inches (125 mm).

    b. Blades:

        1) Hollow, airfoil shape.

        2) Material: Galvanized steel, minimum 0.06 inch (1.6 mm) thick.

        3) Width not to exceed 6 inches (150 mm).

        4) Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

    c. Seals:

        1) Blades: Replaceable, mechanically attached extruded silicone.

        2) Jambs: Stainless steel, compression type.

    d. Bearings:

        1) Stainless steel sleeve type mounted in frame.

2) Where blade axles are installed in vertical position, include thrust bearings.

e. Linkage:

1) Concealed in frame.

2) Constructed of galvanized steel.

3) Hardware: Steel with corrosion-resistant finish.

6. Actuator:

a. Type: Electric, with electrical characteristics compatible with field power supply.

b. Action: modulating or two position.

c. Control Signal: Individual damper assemblies with multiple actuators shall be factory wired to operate in unison from a single control signal.

d. Fail Position: Closed or open, as indicated on Drawings.

e. Mounting on Damper: External.

f. Quantity: Provide each damper assembly with least number of actuators possible for application.

g. Speed of Response:

1) Damper blade operation shall have a controlled movement of at least 5 seconds when travelling from open to close to reduce the potential for damage to duct system and connected equipment.

2) Damper closure shall not be instantaneous under any condition.

3) Operating time for completion of 90-degree damper travel, from open to close, or from close to open, shall not exceed the more stringent of the following:

a) NFPA references indicated.
b) Governing codes.
c) 15 seconds.

Retain "Blade Position Switches" Subparagraph below for remote monitoring of blade position.

7. Blade Position Switches:

a. Provide damper assemblies with limit switches to provide remote indication of damper blade positions.

b. Provide separate limit switches for remote indication of damper blade open position and damper blade closed position.

c. Actuators equipped with remote position indication as an integral part of actuator is acceptable in lieu of separate limit switches only if actuator with integral remote position indication is NRTL listed in accordance with UL 555S.

2.24 FIXED PLATE HEAT EXCHANGERS

A. Fixed Plate Total Heat Exchangers:

1. Source Limitations: Obtain heat exchangers from single source from single manufacturer.

2. Description: A device for purpose of transferring total energy (sensible and latent) from one airstream to another with no moving parts. Design may incorporate parallel, counterflow construction to achieve the energy transfer.

3. Performance: Indicated on Drawings with no cross contamination between exhaust and supply airstreams.

   a. Maximum Pressure Differential: Suitable for maximum 6 inches wg (1500 Pa).

   b. Maximum Temperature: Suitable for maximum 194 deg F (90 deg C).

4. Casing: Galvanized steel.

5. Plates: Evenly spaced, sealed, and arranged for counter airflow.

   a. Plate Material and Coating: Chemically treated paper, or polymer on aluminum, with selective hydroscopicity, moisture permeability, and gas barrier properties.

B. Air-Handling Unit Factory Assembly:

1. Internal Access: Provide each fixed plate heat exchanger with internal access from downstream and upstream sides as indicated on Drawings.

2. Removal and Replacement: Each fixed plate heat exchanger shall be independently removable and replaceable through a removable access panel or door installed in air-handling unit casing.

3. Drain Pans: In applications capable of formation of frost, install condensate drain pans to collect and drain water to exterior of air-handling unit casing.

4. Supports for Fixed Plate Heat Exchanger:

   a. Construct a freestanding and self-supporting structural framework to support heat exchangers.

   b. Construct frame work from aluminum, galvanized-steel, or stainless steel.

5. Comply with fixed plate heat exchanger manufacturer's written installation instructions.

2.25 AIR BLENDERS

A. Source Limitations: Obtain blenders from single source from single manufacturer.

B. Description: Static air mixing devices fabricated in assemblies consisting of multidirectional vanes that are designed to reduce stratification of multiple mixed airstreams and improve uniformity of the air tunnel velocity profile located downstream of air mixer.

C. Performance:

1. Certification: Documented performance verified by tests performed by an independent agency or factory tests witnessed by a professional engineer that is not a company employee.

2. Mixing: Uniform mixed airstream within 6 deg F (3 deg C) of the theoretical average temperature of two or more airstreams.

3. Indicated on Drawings.

D. Construction:

1. Configuration: Indicated on Drawings.

2. Material: galvanized steel or Type 316 stainless steel.

3. Thickness: 0.080 inch (2.06 mm).

4. Attachment: Integral mounting flange for attachment to mounting substrate.

5. Welding: Stitch or continuous welds. Filler metals matched to welded materials.

6. Hardware: Stainless steel.

7. OEM Factory Assembly: Single-piece assembly for sizes through 96 inches (2400 mm). For larger sizes, air mixers shall be fabricated in two pieces, bolted together to ensure proper fit and alignment and then dissembled for shipment.

8. Finish: Anodized.

E. Air-Handling Unit Factory Assembly:

1. Internal Access: Provide each air mixer with internal access from downstream and upstream sides as indicated on Drawings.

2. Install air mixer assemblies in an internal separating wall reinforced to limit deflection to L/200 when subjected to a horizontal force of 200 lb (900 N) at any point on the air mixer assembly.

3. Blank-off and seal assembly to prevent leakage and air bypass around air mixer.

4. Operating Clearance: Maintain upstream and downstream operating clearances in accordance with manufacturer's written installation requirements.

2.26 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Source Limitations: Obtain pumps from single source from single manufacturer.

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.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange or union-end connections.

2. Impeller: ASTM B584, 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 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 [**EPT**] [**FKM**] <**Insert material**> bellows and gasket. Include water slinger on shaft between motor and seal.

D. Motor: Rigidly mounted to pump casing.

1. Enclosure: ODP or TEFC totally enclosed, nonventilated.

2. Enclosure Materials: Cast iron or rolled steel.

3. Motor Bearings: Permanently lubricated or grease-lubricated ball bearings.

4. Efficiency: NEMA Premium efficient.

5. NEMA Design: .

6. Service Factor: 1.15.

2.27 AIR-HANDLING UNIT FACTORY DRAIN PIPING AND PIPING INSULATION

A. General:

1. Air-handling unit manufacturer to factory install piping inside air-handling units.

2. If more than one material is listed, material selection is by air-handling unit manufacturer.

B. Aluminum Piping:

1. Pipe: Aluminum ASTM B241/B241M, Grade 1061, Temper T6, seamless longitudinal joins with beveled or plain ends; and wall thickness as indicated under applications.

2. Fittings: Cast aluminum, ASTM B26/B26M, Grade 356, Temper T6, ASME B16.1 Class 150; threaded ends.

3. Flanges: Cast aluminum, ASTM B26/B26M, Grade 356, Temper T6, ASME B16.1, Class 150 including bolts, nuts, washers, and gaskets of the following end connections and facings:

   a. Threaded end connections for threaded joints, welding-neck with butt-joint for welded joints, and blinds for use with flanged joints requiring close-off.

4. Unions: Cast aluminum, ASTM B26/B26M, Grade 356, Temper T6, hexagonal-stock body; female NPT threaded ends.

C. Copper Tubing:

1. Tubing: Drawn-temper, ASTM B88, Type L (ASTM B88M, Type B).

2. Fittings: Wrought-copper and copper alloy, ASME B16.22, pressure fittings.

3. Unions: Cast-copper-alloy, MSS SP-123, hexagonal-stock body; female NPT threaded ends

4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux in accordance with ASTM B813.

D. Stainless Steel Piping:

1. Pipe: ASME B36.19/ASME B36.19M, stainless steel ASTM A312/A312M, with beveled or plain ends; seamless or welded longitudinal joints, Grade TP316L, and wall thickness as indicated under applications.

2. Fittings, Threaded: MSS SP-114, Class 150, stainless steel ASTM A351/A351M, Grade CF8M.

3. Fittings, Welded: ASME B16.9, stainless steel ASTM A403/A403M, Grade WP316L, seamless, wall thickness to match adjoining pipe.

4. Flanges: Stainless steel ASTM A182/A182M, Grade F316L, ASME B16.5, Class 150 including bolts, nuts, washers, and gaskets of the following material group, end connections, and facings:

   a. Material Group: 2.2.

b. Threaded end connections for threaded joints, welding-neck with butt-joint for welded joints, and blinds for use with flanged joints requiring close-off.

5. Unions: MSS SP-114, Class 150, stainless steel ASTM A351/A351M, Grade CF8M; female NPT threaded ends.

E. Floor Drain Piping:

1. Schedule 40 aluminum or stainless steel pipe with threaded ends or copper tube with soldered threaded male adapters.

2. Factory install a dedicated drain pipe for each floor drain and extend pipe to access side of air-handling unit.

a. Terminate pipe with a threaded pipe cap 3 inches (75 mm) beyond exterior face of air-handling unit casing. Threaded pipe cap material to match pipe material.

b. Pipe size to match size of floor drain connection.

F. Fan Drain Piping:

1. Schedule 40 aluminum or stainless steel pipe with threaded ends or copper tube with soldered threaded male adapters.

2. Factory install a dedicated drain pipe for each housed centrifugal fan with a drain connection and extend pipe to access side of air-handling unit.

a. Terminate pipe with a threaded pipe cap 3 inches (75 mm) beyond exterior face of air-handling unit casing. Threaded pipe cap material to match pipe material.

b. Install a twin sphere EPDM or neoprene pipe connector in the pipe between the fan connection and the pipe penetration through the air-handling unit casing.

c. Pipe size to match size of fan drain connection.

d. Install a threaded union or thread-on flange in drain pipe at connection to fan.

G. Drain Pan Piping:

1. Schedule 40 aluminum or stainless steel pipe with threaded ends or copper tube with soldered threaded male adapters.

2. Factory install drain piping for drain pan(s). Install a dedicated drain pipe for each drain pan serving different air-handling unit internal components. Where multiple drain pans serve like components interconnect drain piping to a single drain pipe for field connection.

a. Where interconnecting cooling coil condensate drain pans from upstream and downstream sides of cooling coil, provide pipe with a water seal trap configured to prevent air bypass.

b. Terminate pipe with a threaded pipe cap 3 inches (75 mm) beyond exterior face of air-handling unit casing. Threaded pipe cap material to match pipe material.

c. Drain pipe size to match size of drain pan connection.

H. Piping Insulation:

1. Factory insulate bottom cooling coil drain pan pipe with 1-inch- (25-mm-) thick, flexible elastomeric insulation where pipe is located under and outside of the air-handling unit casing but within the air-handling unit base.

2. Factory insulate steam and steam condensate piping located inside of air-handling with 2-inch- (25-mm-) thick, preformed mineral-fiber pipe insulation.

3. Cover pipe insulation with a factory-applied aluminum or stainless steel jacket.

2.28 AIR-HANDLING UNIT FACTORY HYDRONIC PIPING AND PIPING INSULATION

A. Chilled-Water Piping:

1. Design Pressure and Temperature: See Drawings.

2. Pipe: ASME B36.10M, carbon steel ASTM A53/A53M, with beveled or plain ends; electric resistance weld or seamless longitudinal joints, Grade B; standard weight.

3. Fittings, Threaded: Malleable iron, ASME B16.3; Class 150.

4. Fittings, Butt Welded: ASME B16.9, wrought-steel ASTM A234/A234M, Grade WPB, seamless or welded, wall thickness to match adjoining pipe.

5. Flanges, Weld: Weld-neck, forged carbon-steel, ASME B16.5; Class 150.

6. Unions, Threaded: Malleable iron, ASME B16.39; Class 150.

7. Strainers: Y-pattern; body and cap constructed of cast-iron, ASTM A126, Class B, removable basket constructed of Type 304 or Type 316 stainless steel with openings not larger than 0.032 inch (0.8 mm); Class 125 or Class 250.

8. Valves:

a. Ball: Two-piece with threaded ends, MSS SP-110, 600 WOG; cast-bronze or forged copper-alloy body, stainless steel vented ball, corrosion-resistant plastic-coated handle, extended stem, and stationary outer sleeve to protect insulation vapor seal.

b. Butterfly: Lugged body; MSS SP-67; cast-iron, ductile-iron, or cast-steel body; stainless steel disk, EPDM seat, and lever or gear operator; rated for system pressure, but not less than 250-psig (1724-kPa) bi-directional dead-end shutoff with downstream flange removed.

c. Check: Globe-style, MSS SP-125; cast-iron ASTM A126 body, stainless steel spring, and bronze seat; Class 125 or Class 250.

9. Vents: Cast-iron body, stainless steel float, NPS 1/2 (DN 15) or larger inlet connection.

10. Flow Meters: In-line electromagnetic type with integral display and accuracy within 3 percent of reading.

11. Pressure Gauges: Bourdon-tube, ASME B40.100 with Grade A or Grade B accuracy; metal case with nominal 4-1/2-inch (114-mm) shatter-resistant glass face and NPS 1/2 (DN 15) threaded brass connection.

12. Test Plugs: Brass or stainless steel body with core inserts and gasketed and threaded cap, extension for insulation; threaded NPS 1/2 (DN 15) connection.

13. Thermometers: Bi-metal actuated, ASME B40.200 with 1 percent accuracy; adjustable-angle stainless steel case with nominal 5-inch (125-mm) shatter-resistant glass face. Include thermometers with stainless steel extended-neck thermowells.

14. Air-Handling Unit Factory Assembly: Factory install a complete piping system inside air-handling units as indicated on Drawings.

a. NPS 2 (DN 50) and smaller with threaded fittings, strainers, and valves. Larger sizes with welded joints, fittings, and flanges for valves and strainers.

b. Arrange piping with sufficient clearance between piping and other components to accommodate removal and replacement of installed components.

c. Gradually slope piping for venting and drainage.

d. Include threaded drain connections and ball valves with threaded hose-end, cap, and chain at all low points in piping.

e. Comply with requirements indicated on Drawings.

f. Make connections to coils with a flange or union.

g. Connect to each coil inlet with shutoff valve, test plug, strainer pressure gauge and thermometer.

h. Connect to each coil outlet with balancing valve, test plug, pressure gauge thermometer flow meter and shutoff valve.

i. Connect each coil drain connection with a drain valve, which is full size of drain connection.

j. Connect each coil vent connection with automatic vent, which is full size of vent connection.

k. Connect to each pump inlet with flange or union, shutoff valve, test plug, strainer and pressure gauge.

l. Connect to each pump outlet with flange or union, check valve, balancing valve, test plug, pressure gauge flow meter and shutoff valve.

m. Include with each strainer a blowdown connection consisting of a nipple and threaded ball valve with threaded hose-end, cap, and chain.

B. Chilled-Water Piping Insulation and Identification:

1. Insulation: Preformed, cellular glass or flexible elastomeric; minimum 2 inches (50 mm) thick.

2. Adhesive: Compatible with insulation material and recommended in writing by insulation manufacturer.

3. Jacket: ASJ.

4. Air-Handling Unit Factory Assembly: Continuously insulate and vapor seal piping system throughout its entire length. Insulate all surface capable of forming condensation.

a. Install high-density insulation insert products, consisting of two 180-degree halves, at pipe hangers and supports. Material density sufficient to accommodate loading without deformation.

b. Insulation thickness determined by air-handling unit manufacturer to comply with governing codes, ASHRAE/IES 90.1, and minimum thickness indicated and to prevent condensation.

c. Insulate piping system only after successful completion of pressure tests.

d. Install adhesive-backed acrylic identification labels indicating pipe size service and direction of flow at multiple locations sufficient for operators to easily follow the flow path. Each branch pipe should have at least one label.

C. Heating Water Piping:

1. Design Pressure and Temperature: See Drawings.

2. Pipe: ASME B36.10M, carbon steel ASTM A53/A53M, with beveled or plain ends; electric resistance weld or seamless longitudinal joints, Grade B; standard weight.

3. Fittings, Threaded: Malleable iron, ASME B16.3; Class 150.

4. Fittings, Butt Welded: ASME B16.9, wrought-steel ASTM A234/A234M, Grade WPB, seamless or welded, wall thickness to match adjoining pipe.

5. Flanges, Weld: Weld-neck, forged carbon-steel, ASME B16.5; Class 150.

6. Unions, Threaded: Malleable iron, ASME B16.39; Class 150.

7. Strainers: Y-pattern; body and cap constructed of cast-iron, ASTM A126, Class B, removable basket constructed of Type 304 or Type 316 stainless steel with openings not larger than 0.032 inch (0.8 mm); Class 125 or Class 250.

8. Valves:

    a. Ball: Two-piece with threaded ends, MSS SP-110, 600 WOG; cast-bronze or forged copper-alloy body, stainless steel vented ball, corrosion-resistant plastic-coated handle, and extended stem.

    b. Butterfly: Lugged body; MSS SP-67; cast-iron, ductile-iron, or cast-steel body; stainless steel disk, EPDM seat, and lever or gear operator; rated for system pressure, but not less than 250-psig (1724-kPa) bi-directional dead-end shutoff with downstream flange removed.

    c. Check: Globe-style, MSS SP-125; cast-iron ASTM A126 body, stainless steel spring, and bronze seat; Class 125 or Class 250.

9. Vents: Cast-iron body, stainless steel float, NPS 1/2 (DN 15) or larger inlet connection.

10. Flow Meters: In-line electromagnetic type with integral display and accuracy within 3 percent of reading.

11. Pressure Gauges: Bourdon-tube, ASME B40.100 with Grade A or Grade B accuracy; metal case with nominal 4-1/2-inch (114-mm) shatter-resistant glass face and NPS 1/2 (DN 15) threaded brass connection.

12. Test Plugs: Brass or stainless steel body with core inserts and gasketed and threaded cap, extension for insulation; threaded NPS 1/2 (DN 15) connection.

13. Thermometers: Bi-metal actuated, ASME B40.200 with 1 percent accuracy; adjustable-angle stainless steel case with nominal 5-inch (125-mm) shatter-resistant glass face. Include thermometers with stainless steel extended-neck thermowells.

14. Air-Handling Unit Factory Assembly: Factory install a complete piping system inside air-handling units as indicated on Drawings.

    a. NPS 2 (DN 50) and smaller with threaded fittings, strainers, and valves. Larger sizes with welded joints, fittings, and flanges for valves and strainers.

    b. Arrange piping with sufficient clearance between piping and other components to accommodate removal and replacement of installed components.

    c. Gradually slope piping for venting and drainage.

d. Include threaded drain connections and ball valves with threaded hose-end, cap, and chain at all low points in piping.

e. Comply with requirements indicated on Drawings.

f. Make connections to coils with a flange.

g. Connect to each coil inlet with shutoff valve, test plug, strainer pressure gauge and thermometer.

h. Connect to each coil outlet with balancing valve, test plug, pressure gauge thermometer flow meter and shutoff valve.

i. Connect each coil drain connection with a drain valve, which is full size of drain connection.

j. Connect each coil vent connection with automatic vent, which is full size of vent connection.

k. Connect to each pump inlet with flange or union, shutoff valve, test plug, strainer and pressure gauge.

l. Connect to each pump outlet with flange or union, check valve, balancing valve, test plug, pressure gauge flow meter and shutoff valve.

m. Include each strainer with a blowdown connection consisting of a nipple and threaded ball valve with threaded hose-end, cap, and chain.

D. Heating Water Piping Insulation and Identification:

1. Insulation: Preformed, cellular glass or phenolic foam Insert material; minimum 2 inches (50 mm) thick.

2. Adhesive: Compatible with insulation material and recommended in writing by insulation manufacturer.

3. Jacket: ASJ.

4. Air-Handling Unit Factory Assembly: Continuously insulate and seal piping insulation system throughout its entire length.

a. Install high-density insulation insert products, consisting of two 180-degree halves, at pipe hangers and supports. Material density sufficient to accommodate loading without deformation.

b. Insulation thickness determined by air-handling unit manufacturer to comply with governing codes, ASHRAE/IES 90.1, and minimum thickness indicated and to prevent condensation.

c. Insulate piping system only after successful completion of pressure tests.

d. Install adhesive-backed acrylic identification labels indicating pipe size service and direction of flow at multiple locations sufficient for operators to easily follow the flow path. Each branch pipe should have at least one label.

E. Piping Hangers and Supports:

1. Finish: Galvanized metallic coatings including pregalvanized, hot-dip galvanized, or electro-galvanized.

2. Hangers: MSS-SP-58, Type 1.

3. Supports: MSS-SP-58, Type 4, Type 24, or Type 37.

4. Threaded Rods: Continuous-thread rod, nuts, and washer made of galvanized steel or stainless steel.

5. Strut: MFMA-4, continuous slotted carbon-steel channel with inturned lips.

6. Air-Handling Unit Factory Assembly:

a. Ridgely support piping from internal structure in accordance with governing codes and MSS SP-58.

2.29 DRAINS

A. Floor Drains:

1. Drain Body: Fabricate floor drain body of NPS 4 (DN 100) or larger aluminum or stainless pipe and weld a plate of same material to the bottom. Option to fabricate an aluminum or stainless steel rectangular box drain at least 4 by 4 inches (100 by 100 mm) of material at least 0.1 inch (3 mm) thick.

2. Drain Connection: Weld a nominal NPS 2 (DN 50) half coupling in side of drain body located within 1 inch (25 mm) from bottom.

3. Drain Cover: Perforated plate, at least 0.1 inch (3 mm) thick, or grating, fabricated from aluminum or stainless steel. Drain cover shall be supported and secured in place by drain body, but not fastened to drain body with fasteners.

4. Fluid Seal: Seal floor drain body to air-handling unit floor for a watertight installation.

5. Mounting: Recess floor drain body into structural base. Top of floor drain to be slightly recessed below air-handling unit finished floor for unobstructed gravity flow from floor into drain.

6. Application: Install floor drains in air-handling unit floors at locations indicated on Drawings.

7. Application: Install floor drains in air-handling unit floors of all sections.

8. Application: Install floor drains in air-handling unit floors of coil coil, heat wheel, heat exchanger, humidifier potentially wet sections and associated access sections.

2.30 FACTORY ASSEMBLED ELECTRICAL

A. Factory install service light fixtures and switches, and receptacles for each air-handling unit.

1. Locate in a convenient and field-accessible location.

2. Installation shall comply with NFPA 70.

3. Wire, Conduit, and Enclosures:

a. Minimum Conduit Size: 3/4 inch (20 mm).

b. Materials: Metal, with a corrosion-resistant finish.

c. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware.

d. Conduit: Locate conduit inside the air-handling unit casing. Conduit installed on exterior of air-handling unit casing is unacceptable.

e. Wire:

1) Copper, rated for 600 V, solid wire for size No. 10 AWG and smaller and stranded wire for larger sizes.

2) Minimum Wire Size: No. 12 AWG.

3) Each circuit shall have a ground wire.

4) Install wire in conduit.

f. Boxes, Conduit Outlet Bodies, and Enclosures:

1) Located in Airstream: NEMA 250, Type 4 Type 4X or Type 12.

2) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 3R or Type 4X

g. Seals: Seal pathways to prevent air leakage between air-handling unit exterior and interior, and between internal component sections.

h. Service Lighting Applications:

1) Provide quantity of 20-A branch circuits required to power service light fixtures.

2) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.

3) Factory install a main disconnect switch field power junction box for interfacing air-handling power for service lighting with single-point field power wiring connection.

i. Receptacle Applications:

1) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.

2) Factory wire receptacles to a main disconnect switch for interfacing air-handling power for receptacles with a single-point field power wiring connection.

B. Main Disconnect Switches: Factory-install main disconnect switch mounted on air-handling unit casing exterior for interface of factory power wiring with field power wiring.

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.

2. Three pole, fused.

3. 600 V rated.

4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 65,000 A.

5. Enclosure:

a. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 3R or Type 4X.

6. Operating handle shall be of box-mounted type that directly drives switch mechanism.

7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.

8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.

9. Include a solid neutral as required by authorities having jurisdiction.

10. Disconnect switch shall have a ground lug for ground wire termination.

11. Operating handle shall be lockable in open position.

12. Horsepower rated.

13. Feed through or double lugged.

C. Field Power Junction Box: Factory-install junction box with internal wire terminal block mounted on air-handling unit casing exterior for interface of factory power wiring with field power wiring.

D. Exterior Service Light Fixtures:

1. LED Luminaires for Outdoors:

a. Basis-of-Design Product: Subject to compliance with requirements,.

b. Finish: Selected by Architect from available finishes offered by manufacturer.

c. Mounting: Wall.

d. Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.

e. Light Color: 4000 K.

f. Light Output: 3000 lumens.

g. On/Off Operation: Photo cell with local override toggle switch.

2. Vaportight Fixtures:

a. Basis-of-Design Product: Refer to lunimare schedule

b. Finish: Selected by Architect from available finishes offered by manufacturer.

c. Mounting: Wall.

d. Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.

e. Cast-aluminum housing and guard with heat-resistant, tempered, clear glass globe.

3. Application: Provide service light fixtures where indicated on Drawings.

4. Application: Provide one service light fixture on each side of air-handling unit with access doors. Position fixture at midpoint of most remote access doors.

E. Interior Service Light Fixtures:

1. Fluorescent Luminaires:

a. Basis-of-Design Product: Subject to compliance with requirements,.

b. Suitable for wet locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.

c. High-impact, UV-stabilized, fiberglass-reinforced polyester housing; high-impact acrylic lens.

2. Application: Provide service light fixtures where indicated on Drawings.

3. Application: Provide one service light fixture in each accessible section of air-handling units.

4. Application: Provide one service light fixture in fan[, **coil**] [**filter**] <**Insert section**> sections of air-handling units.

F. Toggle Switches for Service Light Fixtures:

1. Single-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

2. Two-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

3. Three-Way Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

4. Four-Way Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

5. Lighted Single-Pole Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

a. Description: Handle illuminated when switch is on.

6. Toggle Switch Box and Cover: Mount toggle switch in a [**metal**] [**cast-aluminum**] outlet box with [**cast-aluminum**] [**or**] [**stainless steel**] cover. Weatherproof where exposed to outdoors.

7. Application: Factory install service light switches at locations indicated on Drawings.

8. Application: Factory install a single service light switch to switch all service light fixtures from a single location.

9. Application:

a. Factory install a service light switch for each service light fixture or group of service light fixtures accessible from a single access door adjacent to the access door.

b. Factory install switching configuration (single, three way, or four way) required to operate a single service light fixture or group of service light fixtures from any access door that opens to respective service light fixtures.

10. Switches with Lighted Handles Applications: Lighted handle feature may be omitted where on/off status of internal lights can be viewed through an access door window.

Retain "Receptacles" Paragraph below for air-handling units requiring receptacles.

G. Receptacles:

1. Isolated-Ground Duplex Receptacles, 125 V, 20 A:

   a. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.

   b. Configuration: NEMA WD 6, Configuration 5-20R.

   c. Standards: Comply with UL 498 and FS W-C-596.

2. Duplex GFCI Receptacles, 125 V, 20 A:

   a. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.

   b. Configuration: NEMA WD 6, Configuration 5-20R.

   c. Type: Non-feed through.

   d. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

3. Receptacle Box and Cover: Mount receptacle in a [**metal**] [**cast-aluminum**] outlet box with [**cast-aluminum**] [**or**] [**stainless steel**] cover. Weatherproof where exposed to outdoors.

4. Applications: Factory install a receptacle in a convenient and field-accessible location on air-handling unit exterior of casing [**at locations indicated on Drawings**] [**near access doors accessing fans**] [**near access doors accessing electric heaters and fans**] [**near access doors accessing energy wheels and fans**] [**near access doors accessing electric heaters, energy wheels and fans**] <**Insert locations**>.

H. Power Supply to Fan Motors: As indicated on Drawings.

I. Power Supply to Fan Motors: Factory install a motor controller variable-frequency controller for each fan motor.

1. Locate in a convenient and field-accessible location on unit exterior.

2. Installation shall comply with NFPA 70.

3. Wire, Conduit, and Enclosures:

   a. Minimum Conduit Size: 3/4 inch (20 mm).

   b. Materials: Metal, corrosion resistant and constructed of stainless steel.

c. Motor Termination: Flexible conduit, NRTL listed, not to exceed 36 inches (900 mm) long.

d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware.

e. Wire:

1) Copper, rated for 600 V, solid wire for size [**No. 10 AWG**] <**Insert wire size**> and smaller and stranded wire for larger sizes.

2) Minimum Wire Size: [**No. 12 AWG**] <**Insert wire size**>.

3) Each circuit shall have a ground wire.

4) Install wire in conduit.

f. Boxes, Conduit Outlet Boxes, and Enclosures:

1) Located in Airstream: NEMA 250, [**Type 4**] [**Type 4X**] [**or**] [**Type 12**] <**Insert Type**>.

Retain "Located in Service Corridor" or "Located on Exterior of Air-Handling Unit Casing" Subparagraph below, or both, as applicable.

2) Located in Service Corridor: NEMA 250, [**Type 1**] [**Type 4**] [**or**] [**Type 12**] <**Insert Type**>.

3) Located on Exterior of Air-Handling Unit Casing: NEMA 250, [**Type 3R**] [**Type 4**] [**or**] [**Type 4X**] <**Insert Type**>.

Retain "Disconnect Switches" Paragraph below to require factory-installed disconnect switches.

J. Disconnect Switches:

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.

2. Three pole, [**fused**] [**or**] [**nonfused**].

3. 600 V rated.

4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than [**42,000**] [**65,000**] <**Insert value**> A.

5. Enclosure:

Retain "Located in Service Corridor" or "Located on Exterior of Air-Handling Unit Casing" Subparagraph below, or both, below as applicable.

a. Located in Service Corridor: NEMA 250, [**Type 1**] [**Type 4**] [**or**] [**Type 12**] <**Insert Type**>.

b. Located on Exterior of Air-Handling Unit Casing: NEMA 250, [**Type 3R**] [**Type 4**] [**or**] [**Type 4X**] <**Insert Type**>.

6. Operating handle shall be of box-mounted type that directly drives switch mechanism.

7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.

8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.

9. Include a solid neutral as required by authorities having jurisdiction.

10. Disconnect switch shall have a ground lug for ground wire termination.

11. Operating handle shall be lockable in open position.

12. Horsepower rated.

13. Feed through or double lugged.

Retain "Motor Field Power Junction Box" Paragraph below to require factory-installed motor junction box for connection to field power.

K. Motor Field Power Junction Box:

1. Provide junction box with internal wire terminal block mounted on unit exterior for interface with field power wiring.

a. Provide for each motor not installed with a factory disconnect or controller with integral disconnect.

2. Factory install internal wiring and conduit to motor.

Retain "Motor Controllers" Paragraph below to require factory-installed motor controllers.

L. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.

2. Configured for control of single- or multispeed motors as indicated.

3. Enclosure: Hinged full-front access door with lock and key.

Retain "Located in Service Corridor" or "Located on Exterior of Air-Handling Unit Casing" Subparagraph below, or both, below as applicable.

a. Located in Service Corridor: NEMA 250, [**Type 1**] [**Type 4**] [**or**] [**Type 12**] <**Insert Type**>.

b. Located on Exterior of Air-Handling Unit Casing: NEMA 250, [**Type 3R**] [**Type 4**] [**or**] [**Type 4X**] <**Insert Type**>.

4. Externally Operated[**, Door-Interlocked**] Disconnect: [**Fused disconnect switch**] [**Nonfused disconnect switch**] [**Circuit breaker**] with lockable handle.

5. Short-Circuit Current Rating: As required by electrical power distribution system, but not less than [**42,000**] [**65,000**] [**100,000**] <**Insert value**> A.

6. Hand-Off-Auto Switch: Mounted on face of enclosure.

7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.

8. Control Relays: Time-delay relays.

9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.

Retain "Elapsed-Time Meters" Subparagraph below to add local display of operating hours.

10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.

Retain "Number-of-Starts Counter" Subparagraph below to add local display of fan motor starts.

11. Number-of-Starts Counter: Numerical readout on face of enclosure.

Retain "Variable-Frequency Controllers" Paragraph below to require factory-installed, variable-frequency controllers.

M. Variable-Frequency Controllers:

1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.

2. Enclosure: Unit mounted, with hinged full-front access door with lock and key.

Retain any "Located in Service Corridor" or "Located on Exterior of Air-Handling Unit Casing" Subparagraph below, or both, below as applicable.

a. Located in Service Corridor: NEMA 250, [**Type 1**] [**Type 4**] [**or**] [**Type 12**] <**Insert Type**>.

b. Located on Exterior of Air-Handling Unit Casing: NEMA 250, [**Type 3R**] [**Type 4**] [**or**] [**Type 4X**] <**Insert Type**>.

3. Externally Operated[, Door-Interlocked] Disconnect: [Fused disconnect switch] [Nonfused disconnect switch] [Circuit breaker] with lockable handle.

4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than [**42,000**] [**65,000**] [**100,000**] <**Insert value**> A.

5. Technology: Pulse-width-modulation (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.

9. Operating Requirements:

    a. Input AC Voltage Tolerance: [**10**] <**Insert number**> percent.

    b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.

    c. Capable of driving full motor load, without derating.

    d. Minimum Efficiency: 96 percent at 60 Hz, full load.

    e. Minimum Displacement Primary-Side Power Factor: 95 percent.

    f. Overload Capability: 1.05 times the full-load current for 7 seconds.

    g. Starting Torque: As required by fan and motor drive assembly.

    h. Speed Regulation: 1 percent.

    i. Speed Range: 10:1 speed range.

    j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.

    k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.

11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or need for replacement:

a. Surge suppression.

b. Loss of input signal protection.

c. Critical frequency rejection.

d. Overtemperature.

e. Short circuit at controller output.

f. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.

g. Open circuit at controller output.

h. Input undervoltage.

i. Input overvoltage.

j. Loss of input phase.

k. Reverse phase.

l. AC line switching transients.

m. Instantaneous overload, line to line or line to ground.

n. Sustained overload exceeding 100 percent of controller rated current.

o. Starting a rotating motor.

p. <**Insert features**>.

12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

13. Automatic Reset and Restart:

    a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.

    b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

14. Visual Indication: On face of controller; indicating the following conditions:

    a. Power on.

    b. Run.

    c. Overcurrent and overvoltage.

d. Motor speed (percentage).

e. Various faults with alarm status.

f. Input kilovolt amperes.

g. Power factor.

h. Input kilowatts and kilowatt-hours.

i. Three-phase input and output voltage.

j. Three-phase input and output current.

k. Output frequency.

l. Elapsed operating time (hours).

m. Diagnostic and service parameters.

15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.

16. Hardwired Control Signal Interface: A minimum of [**two**] <**Insert number**> analog inputs (0 to 10 V or 0/4 to 20 mA) and [**four**] <**Insert number**> programmable digital inputs.

17. Remote Communication Interface: [**ASHRAE 135 BACnet MS/TP**] [**ASHRAE 135 BACnet IP**] <Insert requirements>.

18. Line Conditioning:

    a. Input line conditioning.

    b. Output filtering.

    c. EMI/RFI filtering.

19. Bypass Controller:

    a. Bypass Controller/Variable-Frequency Controller Selector Switch: Include manual selector switch on face of enclosure for local operator control of preferred controller.

    b. Bypass Mode: Field-selectable automatic or manual.

Retain first subparagraph below if retaining "Field-selectable automatic or manual" option in "Bypass Mode" Subparagraph above.

1) In automatic mode, include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.

c. Type: Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.

d. Arrangement: Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.

e. Enclosure: Install bypass controller in same enclosure as variable-frequency controller.

f. Remote Monitoring: Include control relay for remote indication of bypass controller operation.

2.31 FACTORY-ASSEMBLED CONTROLS

A. General:

1. Air-handling unit manufacturer shall furnish and factory install control instruments, control power circuit, control transformers, power supplies, wiring, tubing, raceways, and control panels.

2. Provide for a single-point field connection to 120-V electrical power for all factory-installed controls. Terminate power connection with a toggle switch mounted in control panel.

3. Control panel shall serve as field tie-in point for all electric damper actuators, and control instruments located within air-handling unit. Controls for control dampers, control valves and instruments installed in ductwork and piping are not included as part of air-handling unit factory-installed controls.

4. Control instruments shall be installed in accordance with manufacturer's written instructions.

5. Control panel shall house flow, moisture, pressure and temperature transmitters, transformers, dc voltage power supplies, and wiring terminal strip.

6. Carbon dioxide transmitters shall be mounted on air-handling unit casing exterior with sensor port exposed to the airstream.

7. Factory install the following control instruments:

a. Flow station and flow transmitter for each fan.

b. Pressure sensors (inlet and discharge) and one combination pressure differential transmitter, switch, and controller for each filter bank installed in the air-handling unit.

c. Pressure sensor and combination pressure differential transmitter, switch, and controller at the inlet of each fan.

d. Pressure sensor and combination pressure differential transmitter, switch, and controller at the discharge of each fan.

e. Carbon dioxide sensor/transmitters at locations indicated on Drawings.

f. Moisture and temperature sensors and transmitters at locations indicated on Drawings.

g. Temperature switches at locations indicated on Drawings.

h. Control instruments indicated on Drawings.

B. Wire and Cable:

1. Single Conductor Control Wiring above 24 V:

a. Wire size shall be at least No. 16 AWG.

b. Conductor shall be 7/24 soft annealed copper stranding with a 2- to 2-1/2-inch (50- to 65-mm) lay.

c. Conductor insulation shall be 600 V, Type THWN or Type THHN, 90 deg C in accordance with UL 83.

d. Conductor colors shall be black (hot), white (neutral), and green (ground).

2. Single Twisted Shielded Instrumentation Cable above 24 V:

a. Wire size shall be minimum No. 18 AWG.

b. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2-1/2-inch (50- to 65-mm) lay.

c. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.

d. Shielding shall be 100 percent 0.35/0.5-mil aluminum/mylar tape, helically applied with 25 percent overlap, and aluminum side in with a No. 18 AWG-7/26 tinned copper drain wire.

e. Outer jacket insulation shall have a 600-V, 90 deg C rating and shall be Type TC cable.

f. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red, and white.

3. Single Twisted Shielded Instrumentation Cable 24 V and Lower:

a. Wire size shall be minimum No. 18 AWG.

b. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2-1/2-inch (50- to 65-mm) lay.

c. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.

d. Shielding shall be 100 percent 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with a No. 20-22 AWG tinned copper drain wire.

e. Outer jacket insulation shall have a 300-V, 105 deg C rating and shall be Type PLTC cable.

f. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red, and white.

4. Wire and Cable Installation:

a. Comply with manufacturer's written instructions and NFPA 70.

b. Grounding shall be in accordance with IEEE C2. Ground wire shall be copper. Demonstrate ground resistance.

c. Wiring and cables shall be installed in conduit. Exposed wire and cable are unacceptable.

d. Wire and cables may be grouped in a common raceway, except do not group wires and cables from different voltages.

e. Install control wiring in a separate conduit from power wiring.

f. Wiring shall be continuous from terminal to terminal without splices.

g. Do not install low-voltage wire and cable closer than [**12 inches (300 mm)**] <**Insert distance**> from line voltage electrical power wire and cables. Provide an installation free of EMI.

h. Use insulated spade lugs for wiring connection to screw terminals.

i. Use shielded cable to transmitters.

j. Terminate wiring and cables within a control panel, within instrument housing, or in a junction box. Clamp the cable over the jacket, in the junction box. Individual

conductors in the stripped section of cable shall be slack between clamping point and terminal block.

k. Terminate wire and cable in control panel with terminal blocks.

l. Identify each wire and cable on each end and at each terminal with a number coded identification tag. Each wire and cable conductor shall have a unique tag.

m. Perform continuity and meager testing on wiring and cable.

C. Raceways:

1. Conduit:

a. Install wiring and cable in conduit.

b. Minimum Conduit Size: [**1/2 inch (13 mm)**] [**3/4 inch (20 mm)**] <**Insert dimension**>.

c. Materials: Metal, corrosion resistant[**and constructed of stainless steel**].

d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware[**constructed of stainless steel**].

e. Terminations to Actuators and Instruments: Flexible conduit, NRTL listed, not to exceed 24 inches (600 mm) long.

2. Boxes, Conduit Outlet Boxes, and Enclosures:

a. Located in Airstream: NEMA 250, [**Type 4**] [**Type 4X**] [**or**] [**Type 12**] <**Insert Type**>.

b. Located on Exterior of Air-handling Unit Casing: NEMA 250, [**Type 4**] [**or**] [**Type 4X**] <**Insert Type**>.

3. Seals: Seal pathways to prevent air leakage between air-handling unit exterior and interior, and between internal component sections.

4. Conduit Installation:

a. Conduit shall be continuous and secured in a manner that is electrically continuous throughout.

b. Secure threaded conduit entering a cabinet, box or enclosure with a locknut on outside and on inside, such that conduit system is electrically continuous throughout.

1) Install a metal bushing with insulated throat on inside.

2) Locknuts designed to bite into metal, or on inside of enclosure and shall have a grounding wedge lug under locknut.

c. Conduit box connectors for conduit entering enclosures shall be insulated throat type.

d. Connect conduit with watertight sealing locknuts that are suitable for wet applications.

e. Offset conduits where they enter surface-mounted equipment and panels.

f. Neatly loop and lace wiring installed in panels and other enclosures.

g. Seal conduit runs to prevent the circulation of air by installing seal fittings.

h. Install conduit inside of air-handling unit casing. Wiring and conduit running on exterior of air-handling unit casing is unacceptable.

D. Tubing and Fittings:

1. Products in this paragraph are intended for use with the following:

a. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers, and accessories.

2. Copper Tubing:

a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties in accordance with ASTM B75/B75M.

b. Performance, dimensions, weight and tolerance in accordance with ASTM B280.

c. Diameter, as required by application, not less than nominal 0.25 inch (6 mm).

d. Wall thickness, as required by application, but not less than 0.030 inch (0.8 mm).

3. Copper Tubing Fittings: Brass, compression type.

4. Polyethylene Tubing:

a. Fire-resistant black virgin polyethylene in accordance with ASTM D1248, Type 1, Class C and Grade 5.

b. Tubing shall comply with stress crack test in accordance with ASTM D1693.

c. Diameter, as required by application, of not less than nominal 0.25 inch (6 mm).

5. Polyethylene Tubing Fittings: Brass, compression type.

6. Stainless Steel Tubing:

a. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, free from scale.

b. Chemical and physical properties in accordance with ASTM A269/A269M.

c. Diameter, as required by application, of not less than nominal 0.25 inch (6 mm).

d. Wall thickness, as required by application, but not less than 0.035 inch (0.9 mm).

e. Furnish stainless steel tubing in [**20-foot (6-mm)**] straight random lengths.

7. Stainless Steel Tubing Connectors and Fittings:

a. Connectors and fittings shall be stainless steel, with stainless steel collets, flareless type.

b. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.

8. Tubing Installation:

a. Use [**copper**] [**or**] [**stainless steel**] tubing except use fire-resistant polyethylene for tubing located in control panels.

b. Run tubing parallel to, and at right angles to, casing.

c. Route multiple runs of tubing in neat parallel lines.

d. Support tubing as follows:

1) Support metal tubing with hangers, clips, and tube trays.

2) Do not use tapes for mounting tubing.

3) Place a support within 1 foot (0.3 m) of each change in direction and each branch take off.

4) Spacing between supports shall not exceed [**60 inches (1500 mm)**] <**Insert distance**>.

e. Tubing shall not interfere with access to dampers and equipment or obstruct passageways of any kind.

f. Provide vibration loops in tubing when connecting to equipment that might vibrate.

g. Where joining or mating dissimilar metals where galvanic action could occur, provide dielectric isolation.

h. Make tubing bends with a bending tool. Hard bends, or wrinkled or flattened bends are unacceptable.

i. Install tubing fitting make-up in accordance with manufacturer's written instructions.

j. Do not make tubing connections to a fitting before completing make-up connection.

k. Properly align tubing with fitting. Springing tube into position can result in excessive stress on both tubing and fitting with possible resulting leaks.

l. Do not install fittings close to a bend. Length of straight tubing, not deformed by bending is required for a proper connection.

m. Check tubing for correct diameter and wall thickness. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.

n. Wrap threads of fittings with a single wrap of PTFE tape.

o. Install tubing with extreme care to keep foreign matter out. Keep open ends of tubing plugged to keep out dust, dirt, and moisture.

p. Mark each tube on each end with a number-coded identification. Each tube shall have a unique number.

q. Test tubing shall as follows:

1) Test for leaks and obstructions. Disconnect each tubing run before test is run, and blow out trash, condensate, and other foreign material with compressed air.

2) After foreign matter is expelled and the line is free from obstructions, plug the far end of tubing run.

3) Connect a pressure source to the near end with a needle valve between air supply and tubing run. Only commercially pure dry compressed air or nitrogen as distributed in gas cylinders is acceptable for this test.

E. Control Panels:

1. Design control panels for grouping and protecting various electric, and/or electronic components.

2. NRTL listed in accordance with UL 50 or UL 50E.

3. Enclosure:

a. On Exterior of Air-Handling Unit Casing: NEMA 250, [**Type 4**] [**or**] [**Type 4X**] <**Insert Type**>.

4. Construct enclosure of steel, not less than the following:

    a. Enclosure Size Less Than 24 inches (600 mm): [**0.053 inch (1.35 mm)**] [**or**] [**0.067 inch (1.7 mm)**] thick.

    b. Enclosure size 24 inches (600 mm) and Larger: [**0.067 inch (1.7 mm)**] [**or**] [**0.093 inch (2.36 mm)**] thick.

5. Support front panel using a non-removable piano hinge that runs entire height of cabinet.

6. Each panel shall not exceed height of air-handling unit casing and 72 inches (1800 mm) high.

7. Secure front panel with a key locking mechanism. Common key the locks, and provide one pair of keys per panel.

8. Front panel with a window of size so all instrument displays are visible with door closed.

9. Mount panels on exterior wall of air-handling unit casing on primary access side of unit.

10. Paint control panel exterior with enamel at least 5 mils thick. Color of panel exterior and interior shall be white.

11. Include panel field power supply with a toggle-type switch located at entrance inside panel to disconnect power.

12. Include panel with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.

13. Size control panel to provide at least 25 percent spare area on subpanel.

14. Arrange control panel so similar type equipment is grouped together, and a barrier is installed between electrical and electronic equipment.

15. Interior ambient temperature shall not rise above manufacturer's recommended maximum operating temperature for products installed within the panels. Provide filtered louvers and circulating fans, when necessary, to meet criteria.

16. Panel shall serve as a central tie-in point for control devices such as remote sensors, transmitters, power supplies, and transformers.

    a. Factory install internal wiring in compliance with specified standards.

    b. Terminate wiring using an electric terminal strip with heavy-duty terminal blocks.

    c. Include spare terminals, equal to not less than [**10**] [**20**] <**Insert number**> percent of used terminals.

    d. Include spade lugs for stranded wire.

e. Install a maximum of two wires on each side of a terminal.

f. Label each end of cable, wire, and tubing within panel following an approved identification system.

17. Polyethylene tubing may be used within panel enclosure in place of copper.

18. Supply each control panel with a complete set of as-built schematics, tubing, and wiring diagrams that are bound in a three-ring protective binder and located within panel.

19. Mount instruments and other products within control panel on an internal panel(s) and provide with nameplates. Provide engraved, laminated phenolic nameplates (black letters on a white background). Nameplates shall have at least 1/4-inch- (6-mm-) high lettering.

20. Route tubing, cable and wiring located inside control panel within a raceway that has a continuous removable cover.

F. Pitot Tube Airflow Stations:

1. Fan Inlet Airflow Sensor (Piezometer Ring):

a. Source Limitations: Obtain sensors from single source from single manufacturer.

b. Provide fans with airflow measurement integral to fan inlet cones for continuously measurement of air volume flow rate.

c. Fan inlet airflow sensor shall contain multiple pressure sensor points strategically placed along the circumference of the inlet cone and internally connected to an averaging ring manifold located behind the inlet cone.

d. Sensor points shall neither protrude beyond the surface of the inlet cone nor be adversely affected by particle contamination present in the airstream.

e. Sensor shall produce steady, non-pulsating signals to achieve accuracy within 5 percent of actual airflow.

f. Sensor shall be non-intrusive and not impact fan performance.

g. Product shall be a standard offering of fan manufacturer and include published literature with supporting test data to validate sensor performance.

G. Thermal Airflow Measurement Stations:

1. Ebtron

2. Source Limitations: Obtain stations from single source from single manufacturer.

3. Description: Airflow station shall consist of one or more sensor probes and a remotely mounted microprocessor-based transmitter.

4. Performance:

   a. Capable of independently processing up to [**16**] <**Insert number**> independently wired sensor assemblies.

   b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.

   c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output unless temperature sensor has an accuracy of 0.1 deg F (0.06 deg C).

   d. Listed and labeled by an NRTL as successfully tested as an assembly in accordance with UL 873 or UL 60730.

   e. Components shall be interconnected by exposed NRTL-listed plenum-rated cable or non-plenum-rated cable placed in conduit.

   f. Each flow station shall be factory calibrated at a minimum of [**six**] [**16**] <**Insert number**> airflow rates and [**two**] [**three**] <**Insert number**> temperatures to standards that are traceable to NIST.

   g. Individual Sensor Airflow Accuracy: Within [**2**] [**3**] <**Insert number**> percent of reading over the entire operating airflow range.

   h. Thermal Airflow Station Assembly Airflow Accuracy: Within [**2**] [**3**] [**5**] <**Insert number**> percent of reading over the entire operating airflow range.

      1) Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets performance requirements throughout the measurement range.

   i. Temperature Accuracy: Within 0.2 deg F (0.11 deg C) over entire operating range of minus 20 to plus 140 deg F (minus 29 to plus 60 deg C).

   j. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 deg F (Minus 29 to plus 71 deg C).

   k. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 deg F (Minus 29 to plus 49 deg C).

   l. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, noncondensing.

   m. Instrument shall compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.

   n. Pressure Drop: 0.05 inch wg (12.5 Pa) at 2000 fpm (10.2 m/s) across a 24-by-24-inch (600-by-600-mm) area.

o. Instruments mounted in throat or face of fan inlet cone shall not negatively influence fan performance by reducing flow more than [**1**] [**2**] <**Insert number**> percent of Project design flow or negatively impact fan-generated sound. Losses in performance shall be documented with submittal data, and adjustments to compensate for performance impact shall be made to fan to deliver Project design airflow indicated.

5. Sensor Assemblies:

a. Each sensor probe shall contain two individually wired, hermetically sealed [**bead-in-glass**]thermistors.

b. Mount thermistors in sensor using a marine-grade, waterproof material.

c. Thermistor leads shall be protected and not exposed to environment.

d. Each sensor assembly shall independently determine airflow rate and temperature at each measurement point.

e. Each sensor probe shall have an integral cable for connection to remotely mounted transmitter.

f. Sensor Probe Material: Gold anodized, extruded Alloy 6063 aluminum tube or Type 304 stainless steel.

g. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.

6. Transmitter:

a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.

b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.

1) Include an integral power switch to operate on 24-V ac (isolation not required) and include the following:

a) Integral protection from transients and power surges.
b) Circuitry to ensure reset after power disruption, transients, and brownouts.
c) Integral transformer to convert field power source to operating voltage required by instrument.

c. Remote Signal Interface:

1) Linear Analog Signals for Airflow[and Temperature]: Fuse protected and isolated, [**field selectable,**] [**0 to 10 V dc**] [**or**] [**4 to 20 mA**].

2) RS-485: BACnet-ARCNET, BACnet-MS/TP, and Modbus-RTU.

3) 10 Base-T Ethernet: BACnet Ethernet, BACnet-IP, Modbus-TCP, and TCP/IP.

4) LonWorks free topology.

H. Flow Transmitters for Pitot Tube Sensors:

1. Source Limitations: Obtain sensors from single source from single manufacturer.

2. Receives total and static pressure signals from a flow element, amplify, extract the square root, and scale the signal to produce a 4- to 20-mA dc output signal linear to airflow.

3. Housed in NEMA 250, Type 1 enclosure.

4. Assembly constructed so that shock, vibration, and pressures surges of up to 1 psig (6.9 kPa) will neither harm transmitter nor affect its accuracy.

5. Provide transmitter with an automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. Automatic zeroing circuit shall re-zero transmitter to within 0.1 percent of true zero.

6. Performance:

a. Range: At least 20 percent below minimum airflow and 20 percent greater than design airflow.

b. Calibrated Span: Field adjustable, minus 40 percent of the range.

c. Accuracy: Within 0.10 percent of natural span.

d. Repeatability: Within 0.15 percent of calibrated span.

e. Linearity: Within 0.2 percent of calibrated span.

f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.

7. Equip transmitter with an integral digital LED or LCD for continuous indication of airflow.

8. Install in control panel.

I. Humidity Sensors and Transmitters with Digital Display:

1.

2. Source Limitations: Obtain sensors and transmitters from single source from single manufacturer.

3. Performance:

   a. Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 2.5 percent from 90 to 100 percent relative humidity when operating between 60 to 77 deg F (16 to 25 deg C).

   b. Relative Humidity Range: Zero to 100 percent.

   c. Factory calibrated and NIST traceable with certificate included.

4. Construction:

   a. Provide housing with remote sensor probe for ducted applications.

      1) Duct Sensor Body: 300 series stainless steel or chrome-plated aluminum, at least 2 inches (50 mm) long for duct-mounted applications.

      2) Provide sensor with cable for field installation in conduit.

      3) For duct-mounted applications, thread the sensor assembly for connection to a threaded mounting flange.

   b. Provide general-purpose humidity sensor unless application requires special requirements. Provide sensor with sintered stainless steel filter.

   c. Housing shall be ABS/PC plastic or powder-coated aluminum.

   d. Housing Classification: NEMA 250, Type 4 or Type 4X.

   e. Provide housing with wall-mounting plate.

5. Output Signal: Two-wire, 4- to 20-mA output signal with a drive capacity of at least 500 ohms at 24 V dc.

6. Provide unit with a digital display of relative humidity in percent.

J. Air Pressure Sensors:

1. Source Limitations: Obtain sensors from single source from single manufacturer.

2. Insertion length shall be at [**4 inches (100 mm)**] [**6 inches (150 mm)**] [**8 inches (200 mm)**] [**12 inches (300 mm)**].

3. Sensor with four radial holes of 0.04-inch (1-mm) diameter.

4. [**Brass**] [**or**] [**stainless steel**] construction.

5. Sensor with threaded end support, sealing washers, and nuts.

6. Connection: NPS 1/4 (DN 6) compression fitting.

K. Air-Pressure Differential Indicating Transmitter, Switch, and Controller:

1. Source Limitations: Obtain from single source from single manufacturer.

2. Description:

   a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.

   b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.

   c. Select instrument range based on application. Range shall be approximately 2 times set point.

3. Performance:

   a. Accuracy Including Hysteresis and Repeatability:

      1) Within 1 percent for ranges less than 5 inches wg (1250 Pa).

      2) Within 0.5 percent at 77 deg F (25 deg C) for other ranges.

   b. Stability: Within 1 percent per year.

   c. Response Time: 250 ms.

   d. Overpressure: 5 psig (34 kPa) for instrument ranges less than 50 inch wg (12.5 kPa) and 9 psig (62 kPa) for 100-inch wg (25-kPa) range.

   e. Temperature Limits: 32 to 140 deg F (0 to 60 deg C).

   f. Thermal Effects: 0.020 percent per deg F.

   g. Warm-up Period: One hour.

4. Controller Programming through Menu Keys to Access Five Menus:

   a. Security level.

   b. Pressure, velocity, or flow application.

   c. Engineering units.

   d. K-factor for use with flow application.

   e. Set-point control only; set-point and alarm operation; and alarm operation as high, low, or high/low with manual or automatic reset and delay.

   f. View high and low readings.

g. Digital dampening for smoothing erratic applications.

h. Scaling of analog output to fit range and field calibration.

5. Display:

a. Digital, four-digit display with backlight, with 0.4-inch- (10-mm-) high, alphanumeric characters.

b. Four indicators; two for set point and two for alarm status.

6. Operator Interface:

a. Set-point adjustment through keypad on face of instrument.

b. Zero and span adjustments accessible through menu.

c. Programming through keypad.

7. Analog Output Signal:

a. Two-wire, 4- to 20-mA dc current source.

b. Signal capable of operating into a 900-ohm load.

8. Digital Output Signal:

a. Two SPDT relays.

b. Each rated for 1 A at 30 V ac or dc.

9. Construction:

a. Die cast-aluminum casing and bezel.

b. Threaded, NPS 1/8 (DN 6) connections on side and back.

c. Vertical plane mounting.

d. NEMA 250, Type 1.

e. Nominal 4-inch- (100-mm-) diameter face.

f. Mounting Bracket: Appropriate for installation.

L. Carbon Dioxide Sensors/Transmitters:

1. Source Limitations: Obtain sensors/transmitters from single source from single manufacturer.

2. Description:

a. NDIR technology or equivalent technology providing long-term stability and reliability.

b. Two-wire, 4- to 20-mA output signal; linearized to carbon dioxide concentration in ppm.

3. Construction:

a. House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 4.

b. Equip with digital display for continuous indication of carbon dioxide concentration.

4. Performance:

a. Measurement Range: 0 to 2000 ppm.

b. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.

c. Repeatability: Within 1 percent of full scale.

d. Temperature Dependence: Within 0.05 percent of full scale over an operating range of 25 to 110 deg F (minus 4 to plus 43 deg C).

e. Long-Term Stability: Within 5 percent of full scale after more than five years.

f. Response Time: Within 60 seconds.

g. Warm-up Time: Within five minutes.

5. Provide calibration kit. Turn over to Owner at start of warranty period.

M. Air Temperature Sensors:

1. Platinum Resistance Temperature Detector (RTD): Common Requirements:

a. 100 or 1000 ohms at 0 deg C and a temperature coefficient of 0.00385 ohms/ohm/deg C.

b. Two-wire Teflon insulated 22-gauge (0.65-mm) stranded copper leads.

c. Performance Characteristics:

1) Range: Minus 50 to plus 275 deg F (Minus 46 to plus 135 deg C).
2) Interchangeable Accuracy: At 32 deg F (0 deg C) within 0.5 deg F (0.3 deg C).
3) Repeatability: Within 0.5 deg F (0.3 deg C).
4) Self-Heating: Negligible.

d. Transmitter Requirements:

1) Transmitter required for each 100-ohm RTD.
2) Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.

2. Platinum RTD, Averaging Sensor:

a. Source Limitations: Obtain sensors from single source from single manufacturer.

b. [**100**] [**or**] [**1000**] ohms.

c. Temperature Range: Minus 50 to plus 275 deg F (Minus 45 to plus 135 deg C).

d. Multiple sensors to provide average temperature across entire length of sensor.

e. Rigid probe of aluminum, brass, copper or stainless steel sheath.

f. Flexible probe of aluminum, brass, copper or stainless steel sheath and formable to a 4-inch (100-mm) radius.

g. Length: As required by application to cover entire cross section of air tunnel.

h. Enclosure: Junction box with removable cover; NEMA 250, Type 4.

i. Gasket for attachment to duct or equipment to seal penetration airtight.

j. Conduit Connection: 1/2-inch (13-mm) trade size.

N. Air Temperature Switches:

1. Thermostat and Switch for Low Temperature Control:

a. Source Limitations: Obtain switches from single source from single manufacturer.

b. General:

1) Two-position control.

2) Field-adjustable set point.

3) Manual reset.

4) NRTL listed.

c. Performance:

1) Operating Temperature Range: 15 to 55 deg F (Minus 9 to plus 13 deg C).

2) Temperature Differential: 5 deg F (2.8 deg C), non-adjustable and additive.

3) Enclosure Ambient Temperature: Minus 20 to plus 140 deg F (Minus 11 to plus 60 deg C).

4) Sensing Element Maximum Temperature: 250 deg F (121 deg C).

5) Voltage: 120 V ac.

6) Current: 16 full-load A.

7) Switch Type: Two SPDT snap switches operate on coldest 12-inch (300-mm) section along element length.

d. Construction:

1) Vapor-Filled Sensing Element: Nominal 20 feet (6 m) long.

2) Dual Temperature Scale: Fahrenheit and Celsius visible on face.

3) Set-Point Adjustment: Screw.

4) Enclosure: Painted metal, NEMA 250, Type 1.

5) Electrical Connections: Screw terminals.

6) Conduit Connection: 1/2-inch (13-mm) trade size.

O. Air Temperature RTD Transmitters:

1. Source Limitations: Obtain transmitters from single source from single manufacturer.

Requirements in remaining paragraphs are based on Minco's "TT Series." For other transmitters, see Section 230923.27 "Temperature Instruments."

2. House electronics in NEMA 250, Type 1 enclosure. Mount transmitter in control panel.

3. Conduit Connection: 1/2-inch (36-mm) trade size.

4. Functional Characteristics:

a. Input:

1) 100-ohm platinum RTD temperature coefficient of 0.00385 ohms/ohms/deg C; two-wire sensors.

2) 1000-ohm platinum RTD temperature coefficient of 0.00385 ohms/ohms/deg C; two-wire sensors.

b. Span (Adjustable):

1) Exhaust Air: 50 to 100 deg F (10 to 38 deg C).

2) Mixed Air: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).

3) Outdoor: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).

4) Supply Air, Cooling, and Heating: 40 to 120 deg F (4 to 49 deg C).

5) Return Air: 50 to 100 deg F (10 to 38 deg C).

c. Output: 4- to 20-mA dc linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24 V dc.

d. Zero and span field adjustments plus or minus 5 percent of span. Minimum span 50 deg F (28 deg C).

e. Match sensor with temperature transmitter and factory calibrate together.

5. Performance Characteristics:

a. Calibration Accuracy: Within 0.1 percent of span.

b. Stability: Within 0.2 percent of span for at least six months.

c. Combined Accuracy: Within 0.5 percent.

6. Provide each transmitter with a digital display.

P. Liquid Flow Meters:

1. General: Extended range of [**10**] [**20**] <**Insert number**> percent above Project design flow and [**10**] [**20**] <**Insert number**> percent below Project minimum flow to signal abnormal flow conditions.

2. In-Line Body Electromagnetic Flow Meter:

a. Source Limitations: Obtain flow meters from single source from single manufacturer.

b. Description:

1) No moving parts.

2) Suitable for flow measurement of fluids with electrical conductivity more than 5 micro-Seimens per cm.

3) Inherent bi-directional flow measurement.

4) Flow measurement with three pipe diameters upstream and two pipe diameters downstream.

5) Wet calibrate and tag meters to standards traceable to NIST, and provide each meter with a certificate of calibration.

6) Transmitter [integral to] [remote from] meter.

c. Performance:

1) Accuracy for Velocities between 3.3 and 33 fps (1 and 10 m/s): Within 0.2 percent of reading.

2) Accuracy for Velocities between 1.0 and 3.3 fps (0.3 and 1 m/s): Within 0.75 percent of reading.

3) Accuracy for Velocities Less than 1.0 fps (0.3 m/s): Within 0.0075 fps (0.0023 m/s).

4) Ambient Temperature: Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C).

5) Process Temperature: Minus 4 to plus 212 deg F (Minus 20 to plus 100 deg C).

6) Pressure: [**225 psig (1551 kPa)**] [**580 psig (3999 kPa)**].

d. Analog Output Current Signal:

1) Two-wire, 4- to 20-mA dc current source.

2) Signal capable of operating into 1000-ohm load.

3) Isolated.

e. Digital Output Signal: Two, programmable, digital/pulse outputs configurable for frequency, pulse, or directional flow.

f. Operator Interface:

1) Keypad.

2) Digital Display: Multiple-line digital display of alphanumerical characters.

3) LED for normal and alarm operation.

g. Construction:

1) Body: [**Epoxy-coated carbon steel**] [**Type 316 stainless steel**].

PTFE liner offers greater size and temperature range. Consult manufacturer for liner limitations.

2) Body Liner Material: [**PTFE**] [**Ebonite**] [**Polypropylene**].

3) Flow Tube: Type 304 stainless steel.

4) Connection: [**150 Class flange**] [**300 Class flange**] [**Threaded**] [**Wafer**].

5) Electrodes: Type 316 stainless steel. Quantity determined by manufacturer based on application.

6) Electronics Enclosure:

a) Painted aluminum.
a) Removable cover.
b) NEMA 250, Type 4 or Type 6.

3. Vortex Shedding Flow Meter with Integral Pressure and Temperature Measurement:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Source Limitations: Obtain flow meters from single source from single manufacturer.

Requirements in remaining subparagraphs below are based on Onicon's "F-2500 Series." For other flow meter types, see Section 230923.14 "Flow Instruments."

c. Description:

1) Mass flow measurement corrected for density using vortex shedding body with integral piezoelectric pressure sensors and 1000-ohm platinum RTD.

2) Meter NPS 1/2 through NPS 12 (DN 15 through DN 300).

3) Each meter shall be factory calibrated at five points from 0 to 250 fps (0 to 76 m/s) and tagged accordingly against manufacturer's flow standards. Manufacturer shall provide a certificate of calibration for meter.

4) Each meter shall be programmed using Project-specific application data.

5) Meter shall include integral diagnostics to verify installation conditions and proper operation.

d. Performance:

1) Volumetric Flow Accuracy for Liquid: Within 0.75 percent of reading for Reynolds numbers 20000 and larger.

2) Volumetric Flow Accuracy for Steam and Gas: Within 1 percent of reading for Reynolds numbers 20000 and larger.

3) Mass Flow Accuracy for Steam and Gas: Within 1.5 percent of reading for Reynolds numbers 20000 and larger.

4) Repeatability: Within 0.1 percent.

5) Long-Term Stability: Within 0.1 percent per year.

6) Ambient Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

7) Process Temperature: Minus 40 to plus 464 deg F (Minus 40 to plus 240 deg C).

8) Pressure: Equal to flange rating.

e. Output Signals:

1) Analog Current Signal of Flow Rate:

a) Two-wire, 4- to 20-mA dc current source.
b) Signal capable of operating into 1000-ohm load.

2) Analog Current Signals for Pressure and Temperature: Separate 4- to 20-mA signals for gauge pressure and temperature.

3) Digital Signal:

a) Pulse output for flow totalization. Two wire, scaled pulse, 0.5 Hz, 100 mA at 30 V dc.
b) HART, FSK protocol.

f. Operator Interface:

1) Keypad.

2) Digital Display: Two-line digital display of alphanumerical characters. Meter shall display flow rate, flow totalization, pressure, temperature, and support field programming of all parameters.

g. Construction:

1) Material: Type 316L stainless steel.

2) Connection: [**Class 150**] [**Class 300**] [**Class 600**] flange.

3) Enclosure:

a) Epoxy-painted cast aluminum.
b) Removable screw-on cover.
c) NEMA 250, Type 4 or Type 6.
d) Electrical Connection: Screw terminals.
e) Conduit Connection: Two, 1/2-inch (13-mm) trade size.

h. Upstream Flow Straightener:

1) Meter manufacturer shall provide flow straightener where required by installation to comply with manufacturer's written installation instructions.

2) Straightener shall be wafer type, constructed of Type 304 stainless steel, designed to be installed between field-installed flanges.

3) Straightener size shall match meter size.

Q. Liquid Pressure Differential Switches:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Source Limitations: Obtain switches from single source from single manufacturer.

Requirements in remaining subparagraphs below are based on Ashcroft's "LPA, S Series." For other switches, see Section 230923.23 "Pressure Instruments."

3. Description:

a. Type 316 stainless steel double opposing bellows operate to actuate an SPDT snap switch.

b. Wetted Materials: Type 316 stainless steel.

First option in "Seal" Subparagraph below has process temperature limitation of 150 deg F (66 deg C).

c. Seal: [**Buna-N**] [**or**] [**FKM**].

d. Electrical Connections: Screw terminal.

e. Enclosure Conduit Connection: Knock-out or threaded connection.

f. User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.

g. High and Low Process Connections: Threaded, NPS 1/4 (DN 10).

h. Enclosure: NEMA 250, Type 4 or Type 4X.

i. Operating Data:

1) Electrical Rating: 10 A at 120- to 240 V ac.

2) Pressure Limits: 0 to 500 psig (0 to 3447 kPa).

3) Ambient Temperature Limits: Minus 20 to plus 150 deg F (Minus 29 to plus 66 deg C).

"Buna-N" seal has process temperature limitation of 150 deg F (66 deg C). Revise upper temperature limit in "Process Temperature Limits" Subparagraph below if using Buna-N material.

4) Process Temperature Limits: 20 to 300 deg F (Minus 7 to plus 149 deg C).

5) Operating Range: 2 times set point unless otherwise required by application.

6) Deadband: [**Adjustable**] [**Fixed**] [**Adjustable or fixed as required by application**].

j. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

R. Liquid Pressure Transmitters:

1. Liquid Gauge Pressure Transmitter with Adjustable Span:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Source Limitations: Obtain transmitters from single source from single manufacturer.

Requirements in remaining subparagraphs below are based on Rosemount's "Model 3051CG." For other transmitters, see Section 230923.23 "Pressure Instruments."

a. Performance:

1) Range: Minus 300 to 300 psig (Minus 2068 to 2068 kPa).

2) Span: Field adjustable.

3) Minimum Span: 3 psig (21 kPa).

4) Reference Accuracy: Within 0.07 percent of span or better.

5) Stability: Within 0.125 percent of upper range limit for five years.

6) Overpressure Limits: 3626 psig (25 000 kPa).

7) Process Temperature Limits: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

8) Ambient Temperature Limits: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

9) Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.

10) Shock and vibration shall not harm the transmitter.

b. Analog Output Current Signal:

1) Two-wire, 4- to 20-mA dc current source.

2) Signal capable of operating into 1000-ohm load.

3) Digital signal based on HART protocol carried with current signal.

4) Dampening: Field selectable from zero to 30 seconds.

c. Operator Interface: Zero and span adjustments located behind cover.

d. Display: Digital, five-digit, two-line display with 0.4-inch- (10-mm-) high, alphanumeric characters.

e. Construction:

1) Non-wetted parts of transmitter constructed of aluminum or stainless steel.

2) Enclosure with removable cover on each side.

3) Wetted parts of transmitter constructed of Type 316 stainless steel.

4) Threaded, NPS 1/2 (DN 15) process connection on bottom of instrument.

5) Drain/vent valve on process connection.

6) Two 1/2-inch (16-mm) trade size conduit connections on side of instrument enclosure.

7) Screw terminal block for wire connections.

8) NEMA 250, Type 4X.

9) Mounting Bracket: Appropriate for installation.

f. Three-Valve Manifold:

1) Include with each transmitter an integrally mounted manifold.

2) Construct manifold body of Type 316 stainless steel.

3) Manifold with threaded, NPS 1/2 (DN 15) female process connections.

3. Liquid, Pressure-Differential Transmitter with Adjustable Span:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Source Limitations: Obtain transmitters from single source from single manufacturer.

Requirements in remaining subparagraphs below are based on Rosemount's "Model 3051CD." For other transmitters, see Section 230923.23 "Pressure Instruments."

c. Performance:

1) Range: Minus 300 to 300 psig (Minus 2068 to 2068 kPa).

2) Span: Field adjustable.

3) Minimum Span: 3 psig (21 kPa).

4) Reference Accuracy: Within 0.07 percent of span or better.

5) Stability: Within 0.125 percent of upper range limit for five years.

6) Overpressure Limits: 3626 psig (25 000 kPa).

7) Process Temperature Limits: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

8) Ambient Temperature Limits: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

9) Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.

10) Shock and vibration shall not harm the transmitter.

d. Analog Output Current Signal:

1) Two-wire, 4- to 20-mA dc current source.

2) Signal capable of operating into 1000-ohm load.

3) Digital signal based on HART protocol carried with current signal.

4) Dampening: Field selectable from zero to 30 seconds.

e. Operator Interface: Zero and span adjustments located behind cover.

f. Display: Digital, five-digit, two-line display with 0.4-inch- (10-mm-) high, alphanumeric characters.

g. Construction:

1) Non-wetted parts of transmitter constructed of aluminum or stainless steel.

2) Enclosure with removable cover on each side.

3) Wetted parts of transmitter constructed of Type 316 stainless steel.

4) Threaded, NPS 1/2 (DN 15) process connection on bottom of instrument.

5) Drain/vent valve on process connection.

6) Two 1/2-inch (13-mm) trade size conduit connections on side of instrument enclosure.

7) Screw terminal block for wire connections.

8) NEMA 250, Type 4X.

9) Mounting Bracket: Appropriate for installation.

h. Five-Valve Manifold:

1) Include with each transmitter an integrally mounted manifold.

2) Construct manifold body of Type 316 stainless steel.

3) Manifold with threaded, NPS 1/2 (DN 15) female process connections.

S. Liquid Temperature Sensors:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Source Limitations: Obtain sensors from single source from single manufacturer.

Requirements in remaining subparagraphs are based on Minco's "RTD Series." For other sensors, see Section 230923.27 "Temperature Instruments."

3. Resistance temperature (RTD) sensors shall comply with IEC 60751, Class B requirements.

4. Platinum with a value of 100 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.

5. Encase RTD in a Type 316 stainless steel sheath with a 0.25-inch (8-mm) OD.

6. Provide three-wire, PTFE-insulated, nickel-coated, 22-gauge, stranded copper leads.

Retain first subparagraph below for spring-loaded holder. Spring-loaded holder provides direct connect with thermowell for improved temperature measurement.

7. Provide spring-loaded RTDs for thermowell installations.

8. Performance Characteristics:

a. Range: Minus 328 to plus 932 deg F (Minus 200 to plus 500 deg C).

b. Interchangeable Accuracy: Within 0.54 deg F (0.3 deg C) at 32 deg F (0 deg C).

c. Stability: Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F (400 deg C).

d. Hysteresis: Within 0.04 percent of range.

e. Response Time: 62.8 percent of change in four seconds with water flowing across sensor at 3 fps (0.9 m/s).

9. Thermowells:

Requirements in first eight subparagraphs are based on Minco's "TW Series."

a. Stem: [**Straight**] [**or**] [**stepped**] [**or**] [**tapered**] shank formed from solid bar stock.

b. Material: [**Type 304**] [**or**] [**Type 316**] stainless steel.

c. Process Connection: Threaded, NPS 3/4 (DN 20).

d. Sensor Connection: Threaded, NPS 1/2 (DN 15).

e. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.

f. Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends beyond the face of the insulation covering.

g. Length: As required by application and pipe size.

h. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

10. Connection Heads:

Requirements in first four subparagraphs are based on Minco's "CH 359 Connection Head."

a. Housing: Low-copper cast-aluminum alloy, complying with NEMA 250, Type 4.

b. Terminals: Six or eight as required by sensor.

c. Conduit Connection: 1/2-inch (13-mm) trade size.

d. Sensor Connection: NPS 1/2 (DN 15).

11. Assembly: Sensor manufacturer shall furnish sensor, thermowell, and sensor connection head to provide a matched assembly.

T. Liquid Temperature Transmitters:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Source Limitations: Obtain transmitters from single source from single manufacturer.

Requirements in remaining subparagraphs are based on Minco's "TT Series." For other transmitters, see Section 230923.27 "Temperature Instruments."

3. Enclosure: House electronics in NEMA 250, [**Type 4**] [**or**] [**Type 4X**] enclosure.

4. Enclosure Connection: 1/2-inch (13-mm) trade size.

5. Functional Characteristics:

   a. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, three-wire sensors.

   b. Default Span (Adjustable):

      1) Chilled Water: 0 to 100 deg F (Minus 18 to plus 38 deg C).

      2) Heating Hot Water: 32 to 212 deg F (0 to 100 deg C).

      3) <**Insert system and span**>.

   c. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.

   d. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).

   e. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.

6. Performance Characteristics:

   a. Calibration Accuracy: Within 0.1 percent of the span.

   b. Stability: Within 0.2 percent of the span for at least six months.

   c. Combined Accuracy: Within 0.5 percent.

U. Control Transformers:

1. Size each transformer for the total connected load, plus an additional 25 percent of the connected load.

2. Each transformer shall be at least 100 VA.

3. Provide transformer with both primary and secondary fuses.

V. 25-V dc Power Supply:

1. Plug-in style suitable for mating with a standard eight-pin octal socket.

2. Enclose circuitry within a housing.

3. Include line and load regulation to ensure a stable output. To protect both power supply and load, include power supply with an automatic current limiting circuit.

4. Performance:

   a. Output voltage nominally 25 V dc within 5 percent.

   b. Output current up to 100 mA.

   c. Input voltage nominally 120 V ac, 60 Hz.

   d. Load regulation within 0.5 percent from 0- to 100-mA load.

   e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.

   f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

W. Instrument Identification:

1. Engraved tag bearing instrument identification.

   a. Each tag identifying an instrument shall have a unique identification that does not match identification of a similar device.

   b. Tag field instruments identified by equipment being controlled or monitored, followed by point identification used on I/O schematics.

   c. Example: DDC-AHU-01.01; PDIT1.

2. Letter size shall be minimum 1/4 inch (6 mm) high.

3. Letter type shall be sans serif gothic bold style.

4. Lettering and background color scheme shall be white letters on black background.

5. Tag shall be engraved phenolic constructed of three layers of pressure rigid laminate. Top and bottom layers are color-coded, contrasting white center is exposed by engraving through outer layer. Engrave both sides. Material shall be stain proof, heat resistant, non-conductive, or non-corrosive.

6. Tag shall be fastened to equipment/instrument with drive pins or attached with a stainless steel chain.

7. Instruments furnished with identification tags provided by original manufacturer do not require an additional tag.

X. Checkout Procedures:

1. Check instruments for proper location and accessibility.

2. Check instruments for proper installation for direction of flow, elevation, orientation, and other applicable considerations.

3. Damper Check-out: Verify that proper blade alignment, either parallel or opposed, has been provided.

Y. Calibration and Adjustment:

1. Calibrate every instrument.

2. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

3. Equipment and procedures used for calibration shall meet requirements of instrument manufacturer's written instructions. Test equipment used in calibration of instruments shall have an accuracy at least double that of instrument being calibrated.

4. Calibrate each instrument in accordance with the accuracy outlined in instruction manual supplied for instrument by manufacturer.

5. Control System Inputs and Outputs:

   a. Check analog inputs using a precision voltage or current source at zero, 50, and 100 percent of span.

   b. Check analog outputs using a milliampere meter at zero, 50, and 100 percent output.

   c. Check digital inputs using a jumper wire.

   d. Check digital outputs using an ohmmeter to test for contact making or breaking.

   e. Check resistance temperature inputs at zero, 50, and 100 percent of span using a precision-resistant source.

6. Flow: Set differential pressure flow transmitters for zero and 100 percent values with three-point calibration accomplished at 100, 50, and 90 percent of span.

7. Gas: Calibrate gas transmitters at zero, 50, and 100 percent of span.

8. Humidity: Calibrate relative humidity transmitters at zero, 50, and 100 percent of span.

9. Pressure: Calibrate pressure transmitters at zero, 50, and 100 percent of span.

10. Temperature: Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

11. Dampers: Stroke and adjust control dampers following the recommended procedure from manufacturer, such that damper is 100 percent open and closed.

12. Replace out of tolerance instruments failing the test.

13. Provide diagnostic and test instruments for calibration and adjustment.

2.32 SMOKE DETECTORS

Retain "this article if smoked detectors are to be included as part of factory-built air-handling units. If retaining more than one smoke detector type below, indicate smoke detector types on drawings.

Retain "System, Duct Smoke Detectors" Paragraph below for applications that require connection to a conventional fire alarm system. Coordinate interface requirements with fire-alarm system designer.

A. System, Duct Smoke Detectors: For connection to conventional fire-alarm system. Coordinate requirements with Section 284621.13 "Conventional Fire Alarm System."

UL 268A covers detectors that are part of a fire-alarm system and detectors intended solely for control of releasing devices such as dampers.

1. Operating at 24-V dc, nominal.

In first subparagraph below, retain "four" option for additions to existing four-wire systems or if detector auxiliary contacts are used for critical control functions such as air-handler shutdowns. Otherwise, retain type based on class of initiating-device circuit.

2. Detectors shall be [**four**] [**two**]-wire type.

Retain "Base Mounting" Subparagraph below if mounting directly to outlet box is not required. Base-mounted detectors should be used for units with auxiliary alarm outputs.

3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

5. Integral Visual-Indicating Light: LED type, indicating detector has operated[**and power-on status**].

Number of settable levels in fire-alarm control unit varies among manufacturers and between detector types. Indicate specific number of levels on Drawings or in the "Remarks" column of a detector schedule.

6. Provide multiple levels of detection sensitivity for each sensor[**, with alarm-verification feature**].

Coordinate "Duct Smoke Detectors" Subparagraph below with Drawings for power supply and fire-alarm control unit connections. Review two- and four-wire options in "System, Duct Smoke Detectors" Paragraph above.

7. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

    a. Remote indication[and test] station.[Operating key switch initiates an alarm test.]

    b. Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC systems.

    c. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific size, air velocity, and installation conditions where applied.

    d. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

Retain "Nonsystem, Single-Station Duct Smoke Detectors" Paragraph below for applications that do not require connection to a building fire-alarm system.

B. Nonsystem, Single-Station Duct Smoke Detectors:

1. Nonsystem smoke detectors shall be listed as compatible with fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.

2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

3. Comply with UL 268A; operating at 120 V ac.

4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to mounting brackets air-handling unit. Provide terminals in the fixed base for connection to building wiring.

    a. Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific size, air velocity, and installation conditions where applied.

6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

Retain "Air-Handling Unit Factory Assembly" and "Air-Handling Unit Factory Testing" paragraphs below if retaining "System, Duct Smoke Detectors" or "Nonsystem, Single-Station Duct Smoke Detectors" Paragraph above.

C. Air-Handling Unit Factory Assembly:

1. Furnish and install smoke detectors inside air-handling units to comply with governing building codes.

2. Install smoke detectors in accordance with smoke detector manufacturer's written installation instructions.

    a. Sampling tubes shall extend the full width of airstream.

    b. Sampling tubes greater than 36 inches (900 mm) long shall be supported on both ends.

3. Install smoke detectors within air-handling units in a location that is easily accessible for inspection, repair, and replacement of smoke detector, and in a location that does not hinder access to other internal components.

D. Air-Handling Unit Factory Testing: Functionally test smoke detectors to ensure proper operation in accordance with smoke detector manufacturer's written instructions.

Retain "Air-Handling Unit Factory Installation of Addressable Smoke Detectors Furnished by Building Fire-Alarm System Supplier" Paragraph below only if air-handling unit manufacturer is to factory install components of addressable smoke detectors that are furnished by building fire-alarm system supplier.

E. Air-Handling Unit Factory Installation of Addressable Smoke Detectors Furnished by Building Fire-Alarm System Supplier:

1. Where addressable duct smoke detectors are indicated to be installed within air-handling unit casing, air-handling unit manufacturer shall install duct smoke detector components supplied by building fire-alarm system supplier.

2. Mount duct smoke detector sampling housing on exterior of air-handling unit casing. Locate on accessible side and coordinate with installers before installation.

3. Seal air-handling unit casing penetrations.

4. Install duct smoke detector components in accordance with written instructions furnished by supplier.

    a. Sampling tubes shall extend the full width of airstream.

    b. Sampling tubes greater than 36 inches (900 mm) long shall be supported on both ends.

5. Photograph installation and transmit photos to fire-alarm system Installer before air-handling unit shipment to ensure proper installation. Fire-alarm system Installer shall review photos and provide written acceptance of installation to air-handling unit manufacturer before air-handling unit shipment.

    a. Document date of photos and approval for record purposes.

    b. Make corrective measures required by fire-alarm system Installer as required for acceptance.

6. Coordinate work schedule of air-handling unit manufacturer and fire-alarm system supplier to meet requirements of Project schedule.

7. See [**Section 284621.11 "Addressable Fire-Alarm Systems"**] <**Insert Section**> for additional requirements.

2.33 HARDWARE

A. Screws:

1. For Galvanized-Steel Materials: Self-tapping, hex-head, [**zinc-plate steel**] [**or**] [**300 series stainless steel**] screws with a neoprene gasket encapsulated by a [**zinc-plate steel**] [**or**] [**300 series stainless steel**] washer.

2. For Aluminum and Stainless Steel Materials: Self-tapping, hex-head, 300 series stainless steel screws with a neoprene gasket encapsulated by a 300 series stainless steel washer.

3. Provide protective covers on exposed screws to prevent personnel injury.

B. Bolts, Nuts, and Washers:

1. For Joining Galvanized and Painted Carbon-Steel Materials: Hex-head, high-strength, [**galvanized steel**] [**or**] [**300 series stainless steel**].

2. For Joining Aluminum and Stainless Steel Materials: Hex-head, high-strength, 300 series stainless steel.

3. Use washers and lock washers at each bolted connection.

4. Select bolt size and spacing sufficient for load and application.

2.34 WELDING

A. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.

1. Use welding materials with corrosion properties equal to material being welded.

B. Use welders that are certified to weld at least [**twice**]the thickness of the material to be welded. Certification shall be within [**three**] [**six**] <**Insert number**> months of work being performed.

C. Welds shall be continuous, full-penetration welds unless otherwise indicated. Intermittent welds, stitch welds and tack welds are permitted only in specific applications indicated.

D. Use welders and welding procedures complying with the following:

1. Piping Systems: Section IX of the ASME Boiler and Pressure Vessel Code and Section V of ASME B31.1.

2. Structural Aluminum: AWS D1.2/D1.2M.

3. Structural Carbon Steel: AWS D1.1/D1.1M.

4. Structural Stainless Steel: AWS D1.6/D1.6M.

5. Sheetmetal: AWS D9.1/D9.1M.

2.35 PAINTING

A. General:

1. Painted OEM components do not require additional coating other than touch-up to damaged areas. Match the touchup coating to surrounding undamaged surfaces.

2. Finish miscellaneous surfaces to match continuous surfaces.

3. Protect mill galvanized surfaces that are exposed to view, such as raw steel cuts and damage by welding, with multiple coats of matching galvanized paint.

4. Protect mill galvanized surfaces that are concealed, such as raw steel cuts and damage by welding, with multiple coats of zinc-rich paint or matching galvanized paint.

5. Touch up or entirely repaint surface finishes, damaged during shipment and installation, to the original condition, using original materials and methods.

B. Preparation:

1. Submit proposed manufacturer's written preparation and application instructions for information.

2. If paint manufacturer's recommended preparation requirements differ from those indicated, use the more stringent requirements.

3. Structural carbon steel to be painted shall be deburred, ground smooth, cleaned, and blasted in accordance with [**SSPC-SP 6/NACE No. 3**] [**or**] [**SSPC-SP 10/NACE No. 5**].

4. Before applying a primer and a finish coat, remove oil and grease from surfaces to be coated using clean rags soaked in thinner in accordance with SSPC-SP 1.

5. Treat surfaces to be painted to ensure that paint adheres.

C. Primer:

1. Rust-inhibiting type, with a minimum dry film thickness of [**1**] [**2**] <**Insert value**> mil(s) per coat.

2. Apply at least [**two**] <**Insert number**> coats of primer to unfinished carbon-steel surfaces and at least one coat of primer to other surfaces.

3. Use primer that is compatible with substrate and finish coat.

D. Finish Coat:

1. Finish coat painting system shall be [**alkyd-enamel**] [**epoxy**] [**polyurethane**] <**Insert coating**>.

2. Use dry film thickness recommended by paint manufacturer for each coat. Total dry film thickness of all finish coats not less than [**3**] [**5**] <**Insert value**> mils.

3. Painted Surfaces Minimum Properties:

Retain any of "Salt Spray ASTM B117," "Adhesion ASTM D3359," "Acid Resistance ASTM D3260," "Alkali Resistance ASTM D1647," "Humidity Resistance ASTM D2247," and "Pencil Hardness ASTM D3363" subparagraphs below to establish performance requirements for paint system. Tests and results indicated below are representative of paint performance requirements. Consult paint manufacturers for performance related to a specific paint type and revise to suit Project.

a. Salt Spray ASTM B117: 5 percent salt solution fog at 95 deg F (35 deg C) for [**1000**] [**2000**] [**4000**] <**Insert value**> hours with no deterioration.

b. Adhesion, ASTM D3359: When the coating is cut into 0.0625-inch (1.6-mm) squares and 3M No. 600 tape is suddenly removed, there is no loss of adhesion.

c. Acid Resistance ASTM D3260: 15-minute exposure to 10 percent hydrochloric acid at room temperature with no effect.

d. Alkali Resistance ASTM D1647: 15-minute exposure to 10 percent sodium hydroxide at room temperature with no effect.

e. Humidity Resistance ASTM D2247: 850-hour exposure to 100 deg F (38 deg C) and at least 95 percent relative humidity with no effect.

f. Pencil Hardness ASTM D3363: A hardness of 1H.

4. Finish coat color shall be selected by Architect and not be limited to manufacturer's standard offering.

a. Submit a written request for color selection and indicate in the request the date color selection must be returned without impacting schedule.

E. Application: Paint the following surfaces with primer and finish coat indicated:

1. Unfinished carbon-steel surfaces.

Retain any of three subparagraphs below to require a painted exterior casing. It is unnecessary to paint aluminum, galvanized-steel, and stainless steel surfaces for corrosion protection. See the Evaluations for discussion.

2. Exposed mill galvanized-steel surfaces of air-handling unit casing exterior.

3. Exposed aluminum surfaces of air-handling unit casing exterior.

4. Exposed stainless steel surfaces of air-handling unit casing exterior.

2.36 CLEANLINESS REQUIREMENTS

A. General:

1. Provide equipment that has been manufactured, shipped, stored, and installed maintaining highest degree of cleanliness possible.

Retain "Owner Cleanliness Inspection" Subparagraph below to require Owner inspection. Consult Owner to determine if requirement is necessary.

2. Owner Cleanliness Inspection: Air-handling unit(s) cleanliness is subject to Owner cleanliness inspection [**and must pass a white glove test**]before packaging for shipment.

3. <**Insert requirements**>.

B. During Manufacturing:

1. Clean materials to be free of mill grease, oxidation, dirt, dust, and other impurities before manufacturing and assembly.

2. Protect casing materials from contamination during manufacturing and assembly.

3. Use sealing materials that do not outgas.

4. Provide OEM components and equipment from their respective manufacturers free of grease, oxidation, and dirt. Store OEM components and equipment indoors. Cover and protect OEM components and equipment to maintain cleanliness. Follow OEM instructions for equipment storage.

C. After Manufacturing:

1. Before shipment, after unit is completely assembled, clean unit inside and out.

a. Vacuum entire inside to remove dirt, dust, and debris using HEPA-filtered vacuum equipment.

b. Purge hard to reach surfaces with dry, oil-free, compressed or bottled nitrogen.

c. Wipe down all surfaces, inside and out, with a residue-free cleaning agent.

2. Protect unit to maintain cleanliness.

D. Shipping:

1. Protect interior and exterior of air-handling unit from exposure to weather dirt, dust, and debris during shipment and rigging.

2. Cover openings with puncture-resistant durable coverings to ensure that cleanliness is maintained inside unit while providing an air- and watertight seal.

E. On-Site Storage:

1. If air-handling unit is to be stored before installation, Installer shall work closely with air-handling unit manufacturer for air-handling unit manufacturer to provide adequate protection at the factory to ensure that cleanliness for both unit interior and unit exterior is maintained. This protection shall remain in place until unit startup is performed.

2. For extended periods of storage, provide a means to rotate fan and motor assemblies on a periodic basis (as recommended in writing by manufacturer) without compromising unit cleanliness.

2.37 ACCESSORIES

A. Tool Kit:

1. Manufacturer shall assemble a tool kit specially designed for use in servicing air-handling units furnished.

2. Include only special tools required to service air-handling unit components not readily available for purchase by Owner service personnel in performing routine maintenance.

3. Place tools in a lockable case with hinged cover.

4. Mark case cover with large and permanent text to indicate special purpose of tool kit, such as "Air-Handling Unit Tool Kit." Text size shall be at least [**1 inch (25 mm)**] <**Insert dimension**> high.

5. Provide a list of each tool furnished and permanently attach the list to underside of case cover. Text size shall be at least [**1 inch (25 mm)**] <**Insert dimension**>high.

2.38 SOURCE QUALITY CONTROL

A. AHRI Compliance:

Retain "AHRI 260 (I-P)" Subparagraph below only when indicating air-handling unit sound levels in accordance with AHRI 260 (I-P).

1. AHRI 260 (I-P): Air-handling unit sound ratings shall be in accordance with AHRI 260 (I-P), "Sound Rating of Ducted Air Moving and Conditioning Equipment."

Retain "AHRI 261 (SI)" Subparagraph below only when indicating air-handling unit sound levels in accordance with AHRI 261 (SI). AHRI 261 (SI) is the SI equivalent to AHRI 260 (I-P).

2. AHRI 261 (SI): Air-handling unit sound ratings shall be in accordance with AHRI 261 (SI), "Sound Rating of Ducted Air Moving and Conditioning Equipment."

3. AHRI 410: Air-handling unit coils shall be rated in accordance with AHRI 410 and shall be listed by AHRI[**and labeled in accordance with AHRI**].

Retain "AHRI 1060 (I-P) Certification" Subparagraph below if retaining "Heat Wheels," "Fixed Plate Heat Exchangers," or "Heat Pipe Heat Exchangers" Article and if AHRI certification is desired. Not all manufacturers offer this certification. Consult manufacturers.

4. AHRI 1060 (I-P) Certification: Air-handling units that include [**energy wheels**] [**fixed plate heat exchangers**] [**and**] [**heat pipe heat exchangers**] shall be rated in accordance with AHRI 1060 (I-P) and shall be listed by AHRI[**and labeled in accordance with AHRI**].

Retain "AHRI 1061 (SI) Certification" Subparagraph below if retaining "Heat Wheels," "Fixed Plate Heat Exchangers," or "Heat Pipe Heat Exchangers" Article and if AHRI certification is desired. AHRI 1061 (SI) is the SI equivalent to AHRI 1060 (I-P). Not all manufacturers offer this certification. Consult manufacturers.

5. AHRI 1061 (SI) Certification: Air-handling units that include [**energy wheels**] [**fixed plate heat exchangers**] [**and**] [**heat pipe heat exchangers**] shall be rated in accordance with AHRI 1061 (SI) and shall be listed by AHRI[**and labeled in accordance with AHRI**].

B. AMCA Compliance:

1. AMCA 201: Air-handling unit manufacturer shall evaluate fan's performance within the air-handling unit in accordance with AMCA 201, "Fans and Systems" and account for conditions within the air-handling unit that could be detrimental to fan's performance by adjusting the fan performance indicated on Drawings.

2. AMCA 205 Certification: Air-handling unit fan's fan efficiency grade (FEG) shall be rated in accordance with AMCA 205, "Energy Efficiency Classifications for Fans"[**and shall bear the AMCA-certified fan efficiency grade seal**].

3. AMCA 210 Certification: Air-handling unit fan's air performance shall be rated in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"[**and shall bear the AMCA-certified air ratings seal**].

4. AMCA 300: Air-handling unit fan's sound performance shall be rated in accordance with AMCA 300, "Reverberant Room Method for Sound Testing of Fans."

5. AMCA 301 Certification: Air-handling unit fans sound performance shall be rated in accordance with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data"[**and shall bear the AMCA-certified sound ratings seal**].

6. AMCA 500-D: Air-handling unit damper's performance shall be rated in accordance with AMCA 500-D, "Laboratory Methods of Testing Dampers for Rating"[**and shall bear the AMCA-certified air ratings seal**].

C. NFPA Compliance:

1. NFPA 70: Electrical components, devices, and accessories shall be listed and labeled by a qualified testing agency, and marked for intended location and application.

2. NFPA 90A: Design, fabrication, and installation of air-handling units and components shall comply with NFPA 90A.

D. UL Compliance:

Retain "UL 1598 Certification" Subparagraph below if retaining "Antimicrobial Ultraviolet (UV) Lamp Systems" Article and if certification is desired. Not all UVGI manufacturers offer this certification. Consult UVGI manufacturers.

1. UL 1598 Certification: Air-handling unit UVGI shall be NRTL listed and labeled in accordance with UL 1598, "Luminaires."

2. UL 1995 Certification: Where indicated, air-handling unit components shall be NRTL listed and labeled in accordance with UL 1995, "Standard for Safety Heating and Cooling Equipment."

2.39 SOURCE QUALITY CONTROL - INDEPENDENT LABORATORY TESTING

A. General:

1. Project-specific testing by an independent laboratory is not required if air-handling unit manufacturer has written independent laboratory test results of past tests performed on same casing construction proposed for use on this Project.

2. If Project-specific testing is required, testing shall be performed in ample time to include test reports with submittals and before manufacturing of air-handling units. Include sufficient lead time for unit delivery, installation, and testing required by construction schedule.

Retain "Casing Structural Deflection Test" Paragraph below to verify that casing construction complies with requirements before air-handling unit manufacturing begins. Casing testing before unit assembly provides assurance that casing complies with performance requirements while reducing risks associated with noncompliant air-handling units that are factory tested after assembly.

B. Casing Structural Deflection Test:

1. Include service of an independent testing laboratory to verify casing structural deflection requirements indicated.

a. In lieu of independent laboratory testing, manufacturer may perform factory deflection testing of proposed construction to prove compliance if witnessed by [**Architect**] [**and**] [**Owner**]. Manufacturer shall bear cost of labor and travel expenses to witness testing.

2. Test casing construction to performance criteria indicated.

3. Test casing construction proposed for use on Project. Include, at a minimum, particulars such as metal materials and thickness, internal support and reinforcing, and insulation material and thickness.

4. Test largest full-size casing panel proposed for use on Project.

5. Test proposed construction of walls, floor, and roof. Include a separate test for each unique casing construction proposed.

6. Submit test reports for each test to show compliance with performance indicated.

Retain "Casing Airborne Sound Transmission Test" Paragraph below for sound-sensitive applications to verify that casing construction complies with requirements before air-handling unit manufacturing begins. Casing testing before unit assembly provides assurance that casing complies with performance requirements while reducing risks associated with noncompliant air-handling units that are factory tested after assembly.

C. Casing Airborne Sound Transmission Test:

1. Include services of an independent testing laboratory to test proposed casing construction for sound transmission. Include a separate test for each unique casing construction proposed.

2. Conduct tests in accordance with ASTM E90.

3. Determine sound transmission class by using ASTM E413.

4. Test proposed construction of walls and roof.

5. Test proposed construction of floor assembly only if air-handling unit is not installed on a concrete housekeeping pad or building structural floor.

6. Submit test reports for each test to show compliance with performance indicated.

Retain "Casing Sound Absorption Test" Paragraph below for sound-sensitive applications to verify that casing construction complies with requirements before air-handling unit manufacturing begins. Casing testing before unit assembly provides assurance that casing complies with performance requirements while reducing risks associated with noncompliant air-handling units that are factory tested after assembly.

D. Casing Sound Absorption Test:

1. Include services of an independent testing laboratory to verify casing sound absorption coefficients for perforated casing panels. Provide a separate test for each unique casing construction proposed.

2. Conduct tests in accordance with ASTM C423 and ASTM E795.

3. Test proposed construction of walls and roof.

4. Submit test reports to show compliance with performance indicated.

2.40 SOURCE QUALITY CONTROL - AIR-HANDLING UNIT FACTORY TESTS

Retain "Witness of Testing" Paragraph below to allow Owner access to witness testing.

A. Witness of Testing: Allow [**Architect**] [**Commissioning Agent**] [**Construction Manager**] [**and**] [**Owner**] <**Insert entity**> access to place where air-handling units are being tested for witness testing.

1. Submit written notification at least [**30**] [**20**] <**Insert number**> days in advance of testing.

2. Schedule testing at mutually agreeable dates and times.

Retain "Witness Testing Travel Expenses" Paragraph below to include the cost of travel in the Construction Contract. Consult Owner to determine if requirement should be included.

B. Witness Testing Travel Expenses:

1. Include in bid the cost of travel expenses to witness factory testing. Total cost for travel expenses shall be clearly indicated separately in bid.

2. Expenses shall include roundtrip [**coach**] [**or**] [**first**] class airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, and dinner), out-of-town ground transportation and parking, and all associated taxes and fees.

3. Exclude other incidental expenses not indicated.

Revise subparagraph below if multiple people are traveling from different locations.

4. Include travel expenses for [**one**] [**two**] <**Insert value**> representative(s) with origin of <**Insert city and state**>.

Retain "Casing Leakage Test" Paragraph below to require factory testing to verify compliance with leakage performance requirements.

C. Casing Leakage Test:

1. Perform a leak test for [**each assembled air-handling unit**] [**each assembled air-handling unit of unique size and arrangement**] <**Insert requirement**>.

2. Follow testing procedures in accordance with ASHRAE 111.

3. Perform leak test before shipping first air-handling unit[**of unique size and arrangement**].

4. Test results shall indicate that units comply with leakage requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.

5. Prepare test reports in accordance with ASHRAE 111.

6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

Retain "Casing Structural Deflection Test" Paragraph below to require factory testing to verify compliance with structural deflection performance requirements. Factory testing of assembled air-handling unit may not be required if retaining "Casing Structural Deflection Test" Paragraph included in "Source Quality Control - Independent Laboratory Testing" Article above.

D. Casing Structural Deflection Test:

1. Perform a structural deflection test for [**each assembled air-handling unit**] [**each assembled air-handling unit of unique size and arrangement**] [**only one air-handling unit with the worst-case condition**] <**Insert requirement**>.

2. Pressurize and load air-handling units to the performance criteria indicated for structural deflection. Test air-handling unit [**floors**] [**walls and roofs**].

3. Test results shall indicate that units comply with deflection requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.

4. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

E. Functional Run Test:

1. Run test each unit before shipment.

2. Test and balance fans to comply with vibration requirements indicated.

3. Energize each electrical device to ensure it is operational.

a. Take meter readings for volts, amperes, and kVAr on each phase leg of each motor.

b. Take meter readings for volts, amperes, and kVAr on each single-phase power connection to field power.

4. Exercise each damper to ensure proper operation.

5. Exercise each access door to ensure proper fit.

6. Exercise each valve to ensure proper operation.

7. Submit a written report for each unit tested. Written report shall include, at a minimum, full name of each person witnessing test, detailed list of each unit component tested, condition observed, and corrective action required. Each line item shall have full name of the person doing the checkout and date and time the checkout was performed.

Retain "Fan Vibration Test" Paragraph below to require air-handling unit factory testing of vibration for applications where further validation of vibration by test is required.

F. Fan Vibration Test:

1. Perform a fan vibration test for [**each assembled air-handling unit**] [**each assembled air-handling unit of unique size and performance**] <**Insert requirement**>.

2. Energize each fan within the air-handling unit after air-handling unit final assembly and perform a vibration analysis with fan operating at design speed[**and at all speeds throughout the range from design to minimum speed**].

3. Three vibration measurements shall be taken for each bearing in horizontal, vertical, and axial directions. Vibration measurements shall be recorded and consist of vibration amplitude verses frequency[**with filter-in**].

4. Fan bearing measurement points shall be marked or scribed on bearings for permanent record.

5. Test results shall indicate that units comply with vibration requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.

6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

Retain "Acoustical Performance Test" Paragraph below to require air-handling unit factory testing of sound for applications where further validation of sound by test is required.

G. Acoustical Performance Test:

1. Perform an acoustical performance test for [**each assembled air-handling unit**] [**each assembled air-handling unit of unique size and performance**] <**Insert requirement**>.

2. Air-handling unit acoustic performance shall be verified by factory test in accordance with AHRI 260 (I-P) or AHRI 261 (SI).

3. Air-handling unit supply-air discharge, return-air inlet, and casing radiated sound components shall be measured with air-handling unit operating at design conditions.

Retain "Testing Location" Subparagraph below to qualify requirements for test location. Requirement may restrict competition. Consult air-handling unit manufacturers to verify compliance.

4. Testing Location: Perform testing in a location complying with AHRI 220, "Reverberation Room Qualification and Testing Procedures for Determining Sound Power of HVAC Equipment."

    a. Test location shall be broadband qualified in accordance with AHRI 220 Section 5.1 and discrete frequency qualified in accordance with Section 5.2.

Retain option in first subparagraph below to qualify requirements for test location. Requirement may restrict competition. Consult manufacturers to verify compliance.

5. Operating conditions used in acoustic testing shall be verified by test in accordance with AMCA 210[**in an AMCA-accredited facility**].

6. Test results shall indicate that units comply with acoustical requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.

7. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

Retain "Airflow Capacity Performance Test" Paragraph below to require factory testing to verify compliance with airflow performance requirements.

H. Airflow Capacity Performance Test:

1. Perform an airflow capacity performance test for [**each assembled air-handling unit**] [**each assembled air-handling unit of unique size and performance**] <**Insert requirement**>.

Retain option in first subparagraph below to qualify requirements for test location. Requirement may restrict competition. Consult air-handling unit manufacturers to verify compliance.

2. Operating conditions shall be verified by test in accordance with AMCA 210[**in an AMCA-accredited facility**].

3. Test results shall indicate that units comply with design airflow requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.

4. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

Retain "Hydronic Piping Systems Testing" Paragraph below for air-handling units with factory-assembled hydronic piping.

I. Hydronic Piping Systems Testing: Pressure test factory-assembled piping systems with compressed air or water at a pressure to comply with governing codes and ASME B31.9, but not less than design pressure indicated.

1. Test results shall indicate that piping systems are without leaks. Make changes to noncompliant piping systems and retest until units comply with requirements.

2. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

Retain "Steam and Condensate Piping Systems Testing" Paragraph below for air-handling units with factory-assembled steam and condensate piping.

J. Steam and Condensate Piping Systems Testing: Pressure test factory-assembled piping systems with compressed air or water at a pressure to comply with governing codes and ASME B31.1 or ASME B31.9 as applicable for service, but not less than design pressure indicated.

1. Test results shall indicate that piping systems are without leaks. Make changes to noncompliant piping systems and retest until units comply with requirements.

2. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

2.41 SOURCE QUALITY CONTROL - OEM COMPONENT FACTORY TESTS

Retain "Air Blender Testing" Paragraph below to verify air blender performance. Project testing is not required if air blender manufacturer can provide sufficient documentation of result of past testing. Consult Owner to discuss needed for testing.

A. Air Blender Testing:

1. Owner-witnessed performance test to demonstrate compliance with performance requirements indicated.

B. Coil Testing:

Retain any of "Hydronic Coils," "Refrigerant Coils," and "Steam Coils" subparagraphs below as applicable. Consult coil manufacturers for available test pressures.

1. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than [**300-psig (2070-kPa)**] <**Insert pressure**> internal pressure.

2. Refrigerant Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than [**300-psig (2070-kPa)**] <**Insert pressure**> internal pressure.

3. Steam Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than to [**300-psig (2070-kPa)**] <**Insert pressure**> internal pressure.

4. Coils to display a tag with inspector's identification as proof of testing.

C. Fan Vibration Testing:

1. Perform a fan vibration test for [**each fan**] <**Insert requirement**>.

2. Energize each fan after final assembly and perform a vibration analysis with fan operating at design speed[**and at all speeds throughout the range from design to minimum speed**].

3. Three vibration measurements shall be taken for each bearing in the, vertical, and axial directions. Vibration measurements shall be recorded and consist of vibration amplitude verses frequency[**with filter-in**].

4. Fan bearing measurement points shall be marked or scribed on bearings for permanent record.

5. Test results shall indicate units comply with vibration requirements indicated. Make changes to noncompliant fans and retest until fans comply with requirements.

6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single fan, report shall include test date and time, test results, and full names of personnel performing tests

and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine air-handling units before installation. Reject units with physical damage, and air-handling unit components that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for the following before installation of air-handling units:

1. Structural substrate mounting and anchorage to verify actual sizes, types, and locations.

2. Piping systems to verify actual sizes, types, and locations of connections.

3. Ductwork and plenums to verify actual sizes, types, and locations of connections.

4. Electrical services and controls to verify actual sizes, types, and locations of connections.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units at locations indicated on Drawings. Unless, otherwise indicated on Drawings, install air-handling units on concrete equipment bases.

1. Install air-handling units on curbs following air-handling unit manufacturer's written procedures.

a. Install gaskets before setting air-handling units on curbs.

b. Secure air-handling units to curbs using stainless steel fasteners.

c. Install curb and fasten to structure.

d. Coordinate curb requirements, attachment, and location before installation.

B. Roof Openings:

1. Provide exact size and location of roof openings to trade installing structural framing and roof structure.

2. Supervise framing of openings to ensure coordinated installation with air-handling units.

C. Equipment Clearances and Access:

1. Arrange installation of air-handling units to provide access space around air-handling units for service and maintenance and for removal and replacement of internal components.

2. Provide clearance and access required by governing codes and NFPA 70.

3. At a minimum, comply with requirements indicated on Drawings and air-handling unit manufacturer's written instructions.

3.3 PROTECTION DURING CONSTRUCTION

A. Exterior Covers: Cover air-handling units during construction with sealed covers to protect air-handling unit casing and externally mounted components from physical damage, dirt, dust and debris, paint splatter, and any other construction materials.

1. Minor physical damage, as determined by Owner, shall be repaired by air-handling unit factory service personnel to factory-finished condition.

2. Replace air-handling units with damage that in any way compromises the performance indicated.

B. Internal Access: Keep access doors locked to maximum extent possible and restrict access to only authorized personnel.

1. Open access doors only during periods authorized work inside air-handling units is required.

2. Coordinate and monitor work inside air-handling units on a shift basis. Lock access doors once work is complete or at the end of each shift.

3. Immediately report unauthorized access and any observed damage to Owner.

3.4 DUCT CONNECTIONS

A. Connect ducts and plenums to air-handling unit connections. Comply with requirements in Section 233113 "Metal Ducts."

B. Connect ducts and plenums to air-handling unit connections with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

C. Provide duct transitions required to make field connections to air-handling units.

D. Arrange ducts and plenums to provide unobstructed access to inside of air-handling units.

3.5 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, provide unobstructed access to inside of air-handling units for service and maintenance.

C. Connect piping to air-handling units with flexible connectors.

D. Drain Pan Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."

1. Make connections to air-handling unit connections with flanges or unions.

2. Extenddrain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.

3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.

4. Install threaded cleanouts at changes in direction.

5. Secure drain piping to structure.

E. Air-Handling Unit Floor Drains: Do not require installation of permanent drain piping.

F. Air-Handling Unit Floor Drain Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."

1. Make connections to air-handling unit connections with flanges or unions.

2. Extenddrain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.

3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.

4. Install threaded cleanouts at changes in direction.

5. Secure drain piping to structure.

G. Chilled-and Hot-Water Coil Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Comply with requirements indicated on Drawings.

2. Make connections to coils with a flange or union.

3. Connect to each coil inlet with shutoff valve, test plug, pressure gauge and thermometer.

4. Connect to each coil outlet with balancing valve, test plug, pressure gauge thermometer flow meter and shutoff valve.

5. Connect each coil drain connection with a drain valve, which is full size of drain connection.

6. Connect each coil vent connection with automatic or manual vent, which is full size of vent connection.

H. Steam and Condensate Coil Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap assembly, and union or flange at each coil return connection.

3.6 ELECTRICAL CONNECTIONS

A. Install field power to each air-handling unit electrical power connection. Coordinate with air-handling unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.7 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.8 STARTUP SERVICE

A. Engage an air-handling unit factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, controls, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.

6. Verify that face-and-bypass dampers provide full face flow.

7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.

8. Comb coil fins for parallel orientation.

9. Verify that proper thermal-overload protection is installed for electric heaters.

10. Install new, clean filters.

11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.9 ADJUSTING

A. Adjust damper linkages for proper damper operation.

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

B. Before turning equipment over to Owner for use, adjust air-handling unit components that require further adjustment for proper operation. Consult air-handling unit manufacturer for instruction.

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

D. Seasonal Adjustments: Make seasonal visits during warranty period to inspect and review operation of equipment. Make necessary adjustments for components observed to require adjustments for proper operation. Prepare and submit a report to Owner documenting each visit, observations, and any adjustments made.

3.10 CLEANING

A. Cleaning Schedule: After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems, and after completing startup service, and immediately before Owner use, clean air-handling units to remove foreign material and construction dirt and dust.

B. Unit Interior: Clean air-handling units internally to factory clean condition. Remove foreign material and construction debris, dirt, and dust.

1. Vacuum clean with HEPA-filtered vacuum and then wipe down with cleaning solution.

2. Clean casing floors, roofs, wall surfaces, access doors, and panels.

3. Clean all internal components, such as, coils, dampers, filter frames, fans, and motors.

4. Clean light fixtures and control devices.

C. Unit Exterior: Clean external surfaces of air-handling units to factory clean condition. Remove foreign material and construction debris, dirt and dust. Vacuum clean with HEPA-filtered vacuum and then wipe down all surfaces with cleaning solution.

D. Cleaning Materials: Use cleaning materials and products recommended in writing by air-handling unit manufacturer.

E. Acceptance: Following unit cleaning submit a written request for review and Owner acceptance.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. After field piping connections are complete, test hydronic coils and connections for leaks.

2. Charge refrigerant coils with refrigerant and test for leaks.

3. Field-Assembly Supervision: Instruct Installer and supervise field installation of first air-handling unit(s) shipped in multiple pieces for field assembly.

4. Roof-Mounted Field-Installation Supervision: Instruct Installer and supervise field installation of first roof-mounted air-handling unit(s).

5. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Field Casing Leakage Test:

1. Perform leak testing of air-handling units that include field assembly of multiple sections. Air-handling units that are shipped and installed as a single piece do not require field testing.

2. Leak test one air-handling unit(s) of each unique size and arrangement randomly selected by Commissioning Agent.

3. Follow procedures complying with ASHRAE 111.

4. Assembled air-handling units shall satisfy leakage criteria indicated. Modify air-handling units that fail to satisfy criteria and retest. For every air-handling unit that fails test, another air-handling unit shall be tested until all air-handling units tested pass leakage criteria on first attempt.

5. Submit a test report for each test indicating test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.

6. Test report shall be in accordance with ASHRAE 111.

7. Witness Testing:

a. Provide written notification at least 30 business days in advance of testing.

b. Testing shall be conducted in presence of testing and balancing agent.

c. Other parties such as Architect, Commissioning Agent, and Owner shall be invited to witness testing with attendance being optional.

E. Field Fan Vibration Test:

1. Perform fan vibration testing for every one out of 10 air-handling unit fans randomly selected by Architect.

2. Test after air-handling unit installation is complete.

3. Three vibration readings shall be taken for each bearing in horizontal, vertical, and axial directions. Record each reading including vibration amplitude verses frequency.

4. Modify fans that fail to satisfy performance criteria and retest. For every fan that fails test, another fan shall be tested until all fans tested pass criteria on first attempt.

5. Submit a report for each fan tested indicating air-handling unit designation, fan designation, test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.

6. Witness Testing:

a. Provide written notification at least 30 business days in advance of testing.

b. Testing shall be conducted in presence of testing and balancing agent.

c. Other parties such as Commissioning Agent, Architect, and Owner shall be invited to witness testing with attendance being optional.

F. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

G. Prepare test and inspection reports.

3.12 OPERATION DURING CONSTRUCTION

A. Operation of air-handling units for temporary cooling, heating, and ventilation is not allowed without Owner authorization.

1. Submit written request for Owner approval by signature with detailed description of operating procedures to be followed including, but not limited to, the following:

a. Description of construction activities while units are operating.

b. Operation:

1) Beginning and ending calendar dates.
2) List each day during week.
3) List start and stop time and hours for each day.

c. Startup procedures and shut-down procedures.

d. Provisions for routine monitoring of unit operation.

e. Provisions to prevent and protect against damage to equipment due to adverse operation such as, low temperature, high temperature, over pressure, fire, smoke, electrical over- and undervoltage and current and electrical fault.

f. Provisions and safeguards for filtration to keep inside of units from getting dirty.

g. Record keeping.

2. If approved by Owner, units used for temporary cooling, heating, and ventilation during and before interior finish work is complete shall include an unconditional complete unit labor and parts warranty to extend at least two years after the warranty indicated expires.

3. Interior and exterior of air-handling units shall be cleaned to a factory-cleaned condition and clean condition must be accepted by Owner.

B. Filtration During Temporary Use:

1. Protect air-handling system ducts (exhaust air, outdoor air, and return air) with temporary filters installed and supported to prevent filter media from collapse and bypass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 8 in accordance with ASHRAE 52.2.

2. Protect air-handling units with open inlets that are not ducted with temporary filters installed and supported to prevent filter media from collapse and by-pass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 8 in accordance with ASHRAE 52.2.

3. Do not operate air-handling units until both temporary and scheduled permanent air-handling unit particulate filters are in place. Temporary filters must be installed upstream of permanent filters while units are operating.

4. Replace temporary and permanent filters used during construction when dirty. After end of temporary use, replace permanent filters with new, clean filters before beginning testing, adjusting and balancing.

C. Comply with SMACNA 008, "IAQ Guidelines for Occupied Buildings under Construction," for procedures to protect HVAC system.

3.13 DEMONSTRATION

A. Engage air-handling unit manufacturer employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

B. Training shall include, but not be limited to, procedures and schedules related to performance, safety, startup and shut down, troubleshooting, servicing, preventive maintenance, and how to obtain replacement parts.

1. Access Doors: Adjustment, gasket removal and replacement, handle removal and replacement, and spare parts.

2. Access Panels: Removal and replacement, adjustment, gasket removal and replacement, and spare parts.

3. Air Blenders: Cleaning, operation, removal, and replacement.

4. Coils: Cleaning, combing fins, draining, venting, removal, and replacement.

5. Controls: Calibration, cleaning, operation, service, removal and replacement, and spare parts.

6. Damper Assemblies: Cleaning, operation, service, removal and replacement, and spare parts.

7. Drain Pans: Cleaning, removal, and replacement.

8. Fan and Motor Assemblies: Cleaning, operation, removal and replacement, service, and spare parts.

9. Filters: Operation, removal and replacement, frame gasket removal and replacement, clip removal and replacement, and spare parts.

10. Fixed Plate heat Exchangers: Cleaning, removal, and replacement.

11. Lights, Receptacles and Switches: Cleaning, operation, service, removal and replacement, and spare parts.

C. Instructor:

1. Instructor shall be factory trained and certified by air-handling unit manufacturer with current training on equipment installed.

2. Instructor's credentials shall be submitted for review by Architect before scheduling training.

3. Instructor(s) primary job responsibility shall be Owner training.

4. Instructor(s) shall have not less than three years of training experience with air-handling unit manufacturer and past training experience on at least three projects of comparable size and complexity.

D. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.

2. Training shall occur before Owner occupancy.

3. Training shall be held at mutually agreed date and time during normal business hours.

4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for a one-hour lunch period and 15-minute break after every two hours of training.

5. Perform not less than eight hours of training.

E. Location: Owner to provide a suitable on-site location to host classroom training.

F. Training Attendees: Assume three people.

G. Training Attendance Records: For record purposes, document training attendees at start of each new training session. Record date, time, brief description of training covered during the session, attendee's name, signature, phone number, and e-mail address. Submit scanned copy of sign-in sheet to Owner for each training session.

H. Training Format: Individual training modules to include classroom training followed by hands-on field demonstration and training.

I. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

J. Training Video Recording: Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

K. Written Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 237343.19

SECTION 238219 - FAN COIL UNITS

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. Ductless fan coil units and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of fan coil unit indicated.

1.4 INFORMATIONAL SUBMITTALS

A. 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 fan coil units 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.

B. Seismic Qualification Certificates: For fan coil units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Coil Unit Filters: Furnish one spare filters for each filter installed.
2. Fan Belts: Furnish one spare fan belts for each unit installed.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.9 WARRANTY

1. Warranty Period: Four years from date of Substantial Completion.
2. Warranty Period (Compressor Only): Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTLESS FAN COIL UNITS

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

1. Airtherm; a Mestek company.
2. Carrier Corporation.
3. Daikin Applied.
4. Engineered Air.
5. Greenheck Fan Corporation.
6. Trane Inc.

B. Fan Coil Unit Configurations: Row split.

1. Number of Heating Coils: One with two-pipe system.
2. Number of Cooling Coils: One withfour-pipe system.

C. Coil Section Insulation: 1/2-inch- (13-mm-) thick, coated glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Main and Auxiliary Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.

F. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.

G. Cabinet: Steel with factory prime coating, ready for field painting.

1. Vertical Unit Front Panels: Removable, steel, with integral stamped discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.

H. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

1. MERV Rating: 6 when tested according to ASHRAE 52.2.
2. Washable Foam: 70 percent arrestance and MERV 3.
3. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.
4. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV 7.

I. Hydronic Coils: Copper tube with corrosion-resistant coating, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

J. Corrosion-Resistant Coating: Coat coils with a corrosion-resistant coating capable of withstanding a 3,000-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
c. ASTM D3359 for cross hatch adhesion of 5B.

2. Application: Immersion.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 50 gloss units on a single angle 60 degree meter.

K. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

L. Factory, Hydronic Piping Package: ASTM B88, Type L (ASTM B88M, Type B) copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. Three-way, two-position control valve for chilled-water coil.
2. Three-way, two-position control valve for hot-water heating coil.
3. Hose Kits: Minimum 400-psig (2758-kPa) working pressure and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
    a. Length: 24 inches (600 mm).
    b. Minimum Diameter: Equal to fan coil unit connection size.
4. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
5. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
6. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C); with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
7. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); 125-psig (860-kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
8. Wrought-Copper Unions: ASME B16.22.

M. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

N. Basic Unit Controls:

1. Control voltage transformer.

2. Wall-mounting thermostat with the following features:

    a. Heat-cool-off switch.
    b. Fan on-auto switch.
    c. Fan-speed switch.
    d. Automatic changeover.
    e. Adjustable deadband.
    f. Exposed set point.
    g. Degree F indication.

O. DDC Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied-Period-Override Operation: Two hours.
3. Unit Supply-Air Fan Operation:

    a. Occupied Periods: Fan runs continuously.
    b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:

    a. Occupied Periods: Open control valve to maintain room temperature.
    b. Unoccupied Periods: Close control valve.

5. Refrigerant-Coil Operation:

    a. Occupied Periods: Start compressor to maintain room temperature or humidistat set point.
    b. Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.

6. Controller shall have volatile-memory backup.

P. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide BACnet interface for central DDC system for HVAC workstation for the following functions:

    a. Adjust set points.
    b. Fan coil unit start, stop, and operating status.
    c. Occupied and unoccupied schedules.

Q. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above finished floor.

E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.

    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 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 test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

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.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity 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 two visits to Project 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 fan coil units.

END OF SECTION 238219

SECTION 26 0100 - BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. The General Conditions of the Contract, Supplementary Conditions of the General Contract, and requirements of Division 01 Specification sections, apply to work under this Division and all following sections of Division 26, 27, 28.

B. Provide labor, materials, temporary facilities, equipment and services to install electrical systems as indicated or required, which includes but is not limited to, masonry, excavation and backfill, concrete, carpentry, painting, conduit sleeves and supports, anchors, vibration and sound isolation, access doors, cutting and patching, and similar work.

C. Provide temporary electricity for electrical work and the work of other trades. Include engineered plans required for permit by authority having jurisdiction for temporary electrical services. Coordinate with General Contractor for power requirement of General contractor and their sub-contractors.

D. Provide commissioning of Electrical Systems per IECC.

E. Provide commissioning of Lighting and Lighting Controls per IECC.

1.2 SECTION INCLUDES

A. Basic electrical requirements for the installation of the electrical systems in Division 26 specifications that apply.

B. Basic electrical requirements for for integration and coordination of Communications systems in Division 27, and Fire Alarm and Detection systems in Division 28.

C. Basic electrical requirements for for integration and coordination of Plumbing systems in Division 22, and HVAC systems in Division 23.

D. Basic requirements as it relates to Intent and interpretations, Abbreviations and Acronyms, Definitions, Regulatory Requirements, Reference Standards, Administrative Requirements, Job Conditions, Permits and Fees, Submittals, Quality Assurance, Delivery, Storage and Handling, Field Conditions, Warranty.

E. Basic requirements as it relates to Product Standards, Substitutions, Owner-Furnished Products, wWorkmanship, Supervision, Equipment Modification, Existing Equipment, Preparation.

F. Basic requirements as it relates to Execution of Workmanship, Supervision, Equipment Modification, Existing Equipment, Preparation, Installation, Repair, Field Quality Control, System Start-Up, Adjusting, Cleaning, Closeout Activities, Protection, Maintenance.

1.3 INTENT AND INTERPRETATIONS

A. It is the intent of these Drawings and Specifications to result in a complete electrical installation in complete accordance with applicable codes and ordinances.

B. Neither the professional activities of the Engineer nor the presence of the Engineer or its employees and subconsultants at a construction/project site shall relieve the Contractor of its obligations, duties, and responsibilities including, but not limited to, construction means, methods, sequence, techniques, or procedures necessary for performing, superintending, and coordinating the Work in accordance with the Contract Documents.

C. Drawings are diagrammatic in character and do not necessarily indicate every required junction box, pull box, ell, etc. Items not specifically mentioned in the specification or noted on the Drawings, but which are obviously necessary to make a complete working installation, shall be included.

D. Drawings and Specifications are complementary. Whatever is called for in either is binding as though called for in both. The more stringent requirements shall govern.

E. Drawings shall not be scaled for rough in measurements or used as submittals. Where drawings are required for these purposes or have to be made from field measurements, take the necessary measurements and prepare the drawings.

F. Symbols used on the Drawings are defined in the Electrical Legend on the Drawings. Symbols indicated on the Legend may not necessarily be required for the Project.

G. If conflicts are discovered in Contract Documents as work progresses, a set of prints marked with red pencil showing recommended modifications shall be submitted to the Architect/Engineer for approval prior to installation.

H. The Drawings indicate the general arrangement of circuits and outlets, locations of switches, panelboards and other work. However, rearrangement and re-circuiting shall not be permitted without specific acceptance.

I. Incidental equipment such as tools, scaffolding, consumable items, testing equipment, appliances and the like shall be provided whether listed or not. Labor, fees, licenses, start up and checkout services shall also be provided.

J. In the event that discrepancies exist or required items or details have been omitted, notify the Architect in writing of such discrepancy or omission at least five days prior to bid date. Failure to do so shall be construed as willingness to supply necessary materials and labor required for the proper completion of this work. For discrepancies which are not reported by Contractor the most stringent requirement shall apply.

K. In the event that additional information is required during construction, request such information from the Architect in writing prior to performing related work. The request for information shall include an explanation of the information required including references to related portions of the Documents and Contractor’s recommendations.

L. Allowances for Contingencies: No change in contract price will be allowed for alternate work which requires approximately the same work to adjust or relocate electrical components or devices as part of the construction coordination work. An adequate allowance shall be included in the bid price for such coordination contingencies and for the additional work required by these coordination adjustments.

1.4 ABBREVIATIONS AND ACRONYMS

A. These specifications include conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpreted as the sense requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where abbreviations and acronyms are used, they mean the recognized name of the trade association, standards-generating organization, authorities having jurisdiction, or other entity applicable to the context of the text provision.

B. Abbreviations shown on the drawing legend shall also apply.

C. CxA: Shall mean Commissioning Agent.

1.5 DEFINITIONS

A. The terms "the Contractor" or "this Contractor" when used in this Division of specifications, shall be construed to mean Contractor for electrical work.

B. Instructions such as "provide the outlets..." shall mean the same as though the words "This Contractor shall" preceded each instruction. "Provide" shall mean "furnish and install."

C. Where the words "accepted" or "acceptable" are used, such "accepted" or "acceptable" action by the Architect/Engineer denotes that the work or equipment item is in conformance with the design concept of the Project and, in general, complies with the pertinent information given in the Contract Documents.

1.6 REGULATORY REQUIREMENTS

A. Errors and omissions in the Contract Documents do not relieve the Contractor from providing the work in accordance with regulatory requirements.

B. Execute and inspect work in accordance with Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed.

C. Conform to all OSHA workplace requirements.

D. Follow requirements of Reference Standards listed in paragraph 1.07 below and listed in other specification sections included in contract document.

E. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

F. Conform to guidelines and requirements of local utility companies.

1.7 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

B. ICC (IBC)-2021 - International Building Code; 2021.

C. ICC (IECC) - International Energy Conservation Code; 2021.

D. ICC (IFC) - International Fire Code; 2021.

E. ICC (IMC) - International Mechanical Code; 2021.

F. ICC (IPC) - International Plumbing Code; 2021.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NFPA 70 - National Electrical Code 2020; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

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

1.8 ADMINISTRATIVE REQUIREMENTS

A. Utility Coordination: Coordinate the installation of equipment with size, location and installation of service utilities.

1. Submit all required documentation for new services with local utilities.

2. Coordinate with Owner and utility companies outages due to interfacing electrical equipment. Outages must be scheduled at least five days in advance and shall be at a time and duration acceptable to the Owner. Outages at a time other than normal working hours, shall not entitle the Contractor to additional overtime or compensation beyond that in the bid.

B. Coordination:

1. Locations of devices, outlets, etc., as shown on the Drawings are approximate unless dimensioned or otherwise noted. Where locations of devices, outlets, etc., are dimensioned or noted on the Drawings, verify location with Architect's representative or with equipment to be supplied. Exact locations of devices, outlets, etc., shall be coordinated with field conditions. Ensure that switches or other electrical devices are mounted such that they are not "trapped" behind opened doors or otherwise rendered inaccessible, regardless of locations indicated on Drawings.

C. Prior to ordering equipment, determine that equipment shall adequately pass through building openings and passage ways providing unobstructed access to final equipment location. Equipment shall be manufactured and shipped in sections for assembly in final equipment location when inadequate building openings and passage ways limit access. Submittals shall indicate sectionalized manufacture of equipment.

D. Before ordering equipment and before work is installed, determine that equipment shall properly fit the space; that required clearances can be maintained and that electrical equipment can be located without interferences between systems, with structural elements or with the work of other trades.

E. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

F. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

G. Scheduling: Schedule work to coordinate with that of other trades to minimize delays.

1. Coordinate materials and product lead times and delivery dates to ensure no delays to construction schedule.

1.9 JOB CONDITIONS

A. Examine the premises and become familiar with existing conditions prior to bidding. No allowance shall subsequently be made for not following this procedure.

B. Protect work, materials, and equipment against theft, injury, or damage until it has been installed, tested, and accepted.

C. Be responsible for damage to the property of the Owner or to the work of other trades due to the electrical work during the construction and warranty period.

D. Ascertain the scope of other trades' responsibilities and determine if the installation of proposed equipment shall affect the operation or code compliance of equipment. Relocate, modify or otherwise revise equipment as required to maintain operational integrity and code compliance.

E. Be responsible for the safety of the workers and others on the construction site.

1.10 PERMITS AND FEES

A. Obtain all permits required for the electrical work on this Project.

B. Pay fees, including service installation and connection charges, aid to construction fees, and permit fees.

C. Coordinate with Owner and General Contractor any fees that will be paid by Owner.

D. No work shall be started prior to obtaining necessary permits and payment of required fees. Work installed prior to obtaining proper permits shall, if required by permitting authority, be redone in compliance with requirements.

E. Notations made on permit or review documents shall be observed. Additional requirements noted by jurisdictional authority shall be made part of the requirements for construction of the Project. Additional costs for implementing jurisdictional authority's requirements, if any, shall be submitted to the Architect prior to construction for review.

A.11 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures in addition to requirements or this section.

B. Shop drawings shall include equipment catalog cuts or manufacturer's printed data identifying: dimensions, weights, recess openings, equipment arrangements, electrical characteristics with bus size, electrical rating, material, wiring diagrams indicating circuit arrangement and NEMA rating for, but not limited to the following:

1. Medium voltage distribution equipment, cable and devices (13..2 kv and above)

2. Low-Voltage Transformers

3. Switchboards

4. Panel boards

5. Motor Control Centers
6. Enclosed Switches and Circuit Breakers
7. Network Lighting Controls
8. Automatic Transfer Switches
9. UPS Equipment
10. Contactors
11. Wiring Devices
12. Interior and Exterior Lighting
13. Hangers and Supports for Electrical Systems
14. Grounding and Bonding
15. Multi-Outlet Assemblies
16. Generators
17. Modular Wiring Systems
18. Electrical Systems Control
19. Fire Detection and Alarm
20. Communication Systems
21. Lightning Protection System
22. Electronic Meters

C. Submittals shall also include ¼" scale layouts of all electrical rooms, telecom rooms, fire alarm rooms and generator rooms. Include all equipment sizes and clearances.

D. Submit composite coordination drawings to include location and routing of the electrical system components in relation to the mechanical ducts, piping and structural beams.

E. Submit resume of qualifications and experience of the superintendent for review by the Architect. Superintendent shall have as a minimum five years of continuous experience on projects of similar size. Resume shall include a listing of experience, projects, and references. Superintendent for this Project may not be changed without approval.

F. The purpose of Submittals is to ensure that Contractor understands design requirements and demonstrates understanding by indicating and detailing intended materials, methods, and proper installation practices. If discrepancies between Submittals and Contract Documents are discovered either prior to or after

Submittals are reviewed, requirements of Contract Documents shall take precedence. Submittals which are submitted, but which are not required by Contract Documents, shall be returned Not Reviewed.

G. Review of Submittals and action recommended as result of review is a courtesy extended to Contractor by Engineer. This review is intended to minimize delivery to job site and installation of materials and equipment that do not meet intent of Construction Documents. Submission of material for review does not alter Contractor's obligation to follow intent of Construction Documents, nor Contractor's responsibility to comply therewith regardless of action noted in Engineers review.

H. Submit a schedule indicating items to be submitted with respective dates prior to submittals. Submittals shall be submitted to allow the Engineer's possession of such for a minimum of two weeks. Take this into account for long lead time items.

I. Product Data: Submittals shall include catalog cut-sheets, manufacturer's data sheets, written descriptions, specification sheets detailing the associated product, item, assembly and installation. Highlight characteristics and features within product data submittals with a yellow highlighting marker to identify compliance with the Drawings and Specifications. Indicate characteristics and features which are missing or vary from the Drawings and Specifications.

J. Refer to individual specification sections included in construction documents for additional specific submittal requirements for product data, shop drawings, samples, test reports, materials or equipment in those sections.

K. Submittals include details, installation drawings, assembly drawings, fabrication drawings, diagrams, etc., which show adaptation or installation of Contractor-furnished products or materials for overall Project. Electronic files, required for preparation of Submittals, shall be compatible with software and software version as decided by Architect or Engineer at time of Submittal production. Electronic files if required for preparation of Submittal may be obtained from Architect or Engineer, at which time an indemnification form releasing the Architect and Engineer from liability for the Contractor’s record drawing changes on such files shall be executed. Include the following:

1. Legend: Match Contract Documents.

2. Format: Sheet size to match Contract Documents with title block indicating Project name, manufacturer's name and logo, date of submittal, content of sheet, and sheet number.

3. Wiring and Control Diagrams: System and equipment wiring diagrams and control diagrams include multiple floor and building separation lines, sizes of conduits, size and number of conductors in each conduit, wiring color code, and identification of terminals and interconnections. Differentiate clearly between factory and field installed wiring. Make diagrams specific to this Project.

4. Floor Plans: Plan titles, scales, north arrows, column lines, and room names and numbers shall match Contract Documents.

L. Submit samples of equipment as indicated or requested.

M. Prior to ordering equipment or beginning installation work, assemble, prepare, and submit shop drawings required for Project. Submit Submittals as required by individual Sections of Specifications. As a minimum, provide product data submittals for equipment indicated on the Drawings whether mentioned in these Specifications or not.

N. Contractor shall thoroughly check Subcontractors' or vendors' Submittals and, after approving Submittals, provide Submittals for review. Partial or incomplete submittals will not be reviewed and will be returned Not Reviewed. Submittals that do not bear Contractor's review stamp shall be returned Not Reviewed.

O. Submittals submitted or re-submitted shall bear a unique Contractor's submittal number. Submittals shall be submitted in Electronic PDF format. PDFs shall be original product catalog pages in PDF format and not scanned image files from a copier or scanner. Engineer shall retain a copy for our records. After review, Submittals shall be returned together with Submittal Review Sheet which indicates comments on Submittals with specific actions such as: No Exception Taken; Make Corrections Noted, Re submittal Not Required; Make Corrections Noted, Re-submittal Required; Rejected; Not Reviewed. Continue to re-submit Submittals until No Exception Taken or Make Corrections Noted, Re submittal Not Required action is indicated. Provide a copy of the original submittal review comments for re-submitted items.

P. The Contractor shall be responsible for extra fees incurred by the Engineer resulting from subsequent review(s) of submittals which fail to meet the requirements herein. Such extra fees shall be deducted from payment to the Contractor.

Q. Product Data: Provide as required by other individual sections of the specifications.

R. Samples: Provide samples as required by other individual sections of the specifications.

S. Certificate: Certify that products of this section meet or exceed specified requirements.

T. Delegated Design Data: Provide as required by other individual sections of the specifications.

U. Test Reports: Provide as required by other individual sections of the specifications.

V. Evaluation Service Reports: Show compliance with specified requirements.

W. Manufacturer's Instructions: Provide as required by other individual sections of the specifications.

X. Source Quality Control Submittals: Provide as required by other individual sections of the specifications.

Y. Field Quality Control Submittals: Provide as required by other individual sections of the specifications.

Z. Manufacturer Reports: Indicate as required by other individual sections of the specifications.

AA. Erection Drawings: Indicate as required by other individual sections of the specifications.

AB. Sustainable Design Documentation: Provide as required by other individual sections of the specifications and by commissioning agent..

AC. Special Procedures Submittals: Indicate as required by other individual sections of the specifications.

AD. Designer's Qualification Statement. Provide as required by other individual sections of the specifications.

AE. Manufacturer's Qualification Statement. Provide as required by other individual sections of the specifications.

AF. Maintenance Contracts. Provide as required by other individual sections of the specifications.

AG. Operation & Maintenance Data: Provide as required by other individual sections of the specifications..

1. Make up the operating and maintenance manuals as specified and submit no later than [2] weeks prior to the completion of the Project.

2. Information contained in the operating and maintenance manuals consist of submittal materials reflecting equipment as supplied and installed, test reports, warranties, description of required testing and testing methods, description of routine maintenance, cleaning, adjustments, and service required, suggested frequency of testing and maintenance, and recommended replacement parts with a list of names, addresses, and telephone numbers of service organizations that carry stock of such replacement parts.

3. Manuals shall be 8-1/2 inch x 11 inch size. Catalog pages and data in manuals shall be neat, clean prints. Larger drawings shall be accordion folded to above size. An index shall be provided which shall list contents in an orderly manner. Each copy of the operating and maintenance manual shall be bound in hard back or loose-leaf binder with hard cover, shall be adequately labeled for identification, and shall include plastic tabs coordinated with Index. Provide a separate tabbed section, with a list of testing required to maintain warranty for products and systems provided as part of this project.

4. Provide two copies of operation and maintenence manuals unless otherwise specified in Division 1 Closeout requirements.

    a. Submit one copy of the manual to the Architect for review prior to preparation of final copies. After review, make changes as noted and prepare 2 final copies of manual to be turned over to the Owner.

    b. This contract shall not be considered completed nor shall final payment be made until specified material, including test reports and warranties are received in this operating and maintenance manual and the manual is approved by the Architect.

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

AI. Project Record Documents as follows:

1. Keep in custody during entire period of construction, a current set of documents indicating changes that have been made to the Contract Documents. Changes to be noted on the documents shall include but shall not be limited to, panelboard, luminaire, equipment, and other schedules; circuiting; equipment, luminaires, or conduit located more that 2 feet from where shown on Drawings; electrical equipment ratings; modifications to Specifications. Incorporate Addenda, accepted Alternates, Change Orders, and other Document revisions which occurred after the award of the General Contract or the start of construction activities into the Record Documents. Notations and changes shall be done in a neat and legible manner in accordance with Architect's and Engineer's instructions. Changes shall be noted in red, deletions in green, and notes in blue.

2. At the completion of the Project, mark equipment designations on the documents. Designations shall match the engraving on the tags installed as called for elsewhere in these specifications.

3. Upon completion of work, develop and submit a complete set of electronic Record Documents (Drawings and Specifications), which incorporate changes documented during construction. The Contract Documents set the standard for content and methods of presentation for the Record Documents. The Record Drawings title blocks shall clearly indicate the Drawings as Record Documents, Contractor’s corporate name and logo (if applicable), and the Record Document submittal date. Electronic files shall be compatible with software and software version as decided by Architect or Engineer at time of Record Drawing production. Electronic files for preparation of

Record Documents may be obtained from Architect or Engineer, at which time an indemnification form releasing the Architect and Engineer from liability for the Contractor's record drawing changes on such files shall be executed.

4. The Contract shall not be considered completed until these Record Documents have been reviewed and accepted by the Architect.

AJ. Sustainable Design Closeout Documentation: as required by other individual sections of the specifications and by commissioning agent..

AK. Software: Copy of software provided under this section or any other individual sections of the specifications.

AL. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:

1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Furnish extra materials, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Owner

1.12 QUALITY ASSURANCE

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

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

C. The manufacturer's material or equipment listed first in the Specifications or on the Drawings are types to be provided for establishment of size, capacity, grade and quality.

D. Additional manufacturer's materials or equipment listed are considered to be "other acceptable" manufacturers and the cost of changes in construction required by their use shall be borne by this Contractor.

E. Review of Submittals for equipment supplied is mandatory as a condition of acceptance of work. Installation of equipment prior to review shall be at Contractor's risk

F. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

G. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver: Make provisions for receiving and storing materials, including Owner furnished materials to be installed under this Division. Carefully mark and store materials. Carefully check and inspect materials furnished for installation, and furnish a receipt acknowledging acceptance of delivery and condition of the materials received. Do not use received materials which contain cracks, dents, abrasions, or other defects. Mark such materials rejected and remove from site or return to supplier for replacement.

B. Store materials and equipment under cover and elevated above grade.

C. Protect materials and equipment from physical damage, construction dirt, and the elements from the time they are delivered until final acceptance. The Contractor installing the equipment or materials shall be responsible for their protection.

1.14 FIELD CONDITIONS

A. Ambient Conditions: Do not install materials or equipment when temperatures are above or below manufacturer recommended ambient conditions..

B. Ambient Conditions: Maintain ambient temperatures at facility during and after installation of materials and equipment.

1.15 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide 1 year manufacturer warranty for materials, workmanship and the successful operation of equipment installed from the date of acceptance of the entire work. Guarantee to repair or replace at Contractor's expense, work which may show defect during that time, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

A. Unless otherwise specified, materials and equipment shall be of domestic (USA) manufacture.

B. Unless otherwise specified, materials and equipment shall be the manufacturer's current model and bear manufacturer's name and model number.

C. All electrical equipment shall be listed and labeled with the Underwriters Laboratory tag or other listing as approved by the local jurisdictional authority. Custom designed items shall be fabricated of UL approved materials and UL listed as a complete assembly as required.

D. Throughout Specifications, various materials, equipment, apparatus, etc., are specified by manufacturer, brand name, type or catalog number. Such designations are to establish standards of desired quality and construction and shall be the basis of the bid. Substitutions shall be allowed only as specified herein.

2.2 SUBSTITUTIONS

A. Material and equipment used in bids shall be as specified. Proposed substitutions shall be reviewed after award of contract during submittal review. Proposed substitutes shall be clearly labeled as a substitute. Submittals shall include data necessary for complete evaluation of the proposed substitution. Substitution materials and equipment used in bids shall be at Contractor's risk, and as such are subject to rejection during submittal review. The Contractor shall be responsible for fees for re-design incurred by the

Engineer resulting from the use of substitution materials. Such extra fees shall be deducted from payment to the Contractor.

B. Where "other acceptable" manufacturers are named, their products may be used provided they totally meet the Specifications and are dimensionally suitable and operationally identical to the specified item. The decision as to whether or not such items are equal to the specified items shall be made by the Architect during submittal review

2.3 OWNER-FURNISHED PRODUCTS

A. Wiring for Equipment Furnished by Others: Provide electrical services to equipment furnished by others. Provide final connections unless otherwise noted. Where final connections are to be made by others, install outlet box and pull in conductors leaving 8 inch pigtails for each conductor. Conductors shall be taped and appropriate cover plate installed over box. Control and alarm wiring for such equipment shall be provided by the equipment supplier or trade providing equipment unless otherwise noted.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. Workmanship shall be first quality throughout and shall be in complete accordance with the applicable codes. The appearance of the work shall be of equal importance to its operation. Lack of quality workmanship shall be considered sufficient reason for rejection of a system in part or in whole.

3.2 SUPERVISION

A. Supervise work so it shall proceed in proper sequence without delay to other trades. The superintendent shall be on the Project site for the duration of the Project to ensure that Contract Documents are being followed. A ratio of not less than 1:1 shall be maintained between journeymen and apprentices.

B. Superintendent shall have as a minimum five years of continuous experience on projects of similar size. Superintendent for this Project may not be changed without approval.

C. The Architect may have an observer on the site whose interpretations of the Contract Documents shall be followed.

3.3 PREPARATION

A. Cutting, Patching, Openings, Sleeves, Inserts and Hangers.

1. Furnish and install sleeves and boxes required for openings in the structure for installation of electrical work. Be responsible for proper placement of sleeves and boxes.

2. Provide inserts and hangers required to support conduit, cables, boxes, fixtures, etc. Provide independent support for all electrical equipment.

3. Properly size and locate holes and chases required for work under this Division as construction progresses. Before beginning sleeving or installation work, carefully study Contract Drawings and check conduit, boxes and equipment locations for interference with other trades. If conflicts are discovered in Drawings or as work progresses, a set of prints marked with red pencil showing recommended installation methods shall be submitted to the Architect for review prior to

installation. Cutting, repairing and required structural reinforcing for installation of this work shall be done in conformance with the Architect's directions. Cutting shall not be done without the Architect's approval.

4. Cutting of concrete or other building materials shall be avoided where possible. Have a workman qualified in the electrical trade present at the pouring of concrete or the building of masonry containing electrical work to avoid cutting of concrete or other building material.

5. Sleeves and chases are prohibited in structural members except where approved by the Architect in writing. If openings necessary for this work are not installed at the time of construction, or if an opening is required in existing construction, provide the opening.

6. Patching in every instance consists of completing the work to match and blend in with the adjoining existing work insofar as methods, materials and colors, and workmanship are concerned. Patches which are not properly blended shall be rejected and ordered redone. Execute patching in full compliance with the provision of the Specifications relating to the type of work involved by craftsmen qualified and skilled in the particular type of work involved.

7. Openings for electrical work shall be carefully caulked or grouted as required. Spare conduits shall be tightly capped.

8. Holes and voids created to extend electrical systems through fire rated floors, walls, and ceilings shall be sealed with an intumescent material.

9. Costs of cutting and patching caused by improper coordination shall be paid for by the Contractor regardless of the responsibilities set forth in these Contract Documents for new work.

B. Equipment received from manufacturer with a prime coat of paint shall be cleaned, sanded and furnished with a final coat of paint.

C. Panelboards, disconnects, and boxes for life safety systems including emergency power and fire alarm equipment shall be painted red.

3.4 INSTALLATION

A. Install in accordance with manufacturer's instructions, unless local codes or regulations take precedence.

B. Install so that equipment can be easily serviced. Maintain, as a minimum, code required clearances.

C. Place or replace equipment identification in locations where they can be seen and read without difficulty.

D. Perform work in accordance with good commercial practice. The appearance of the finished work shall be of equal importance to its operation.

E. Installation of work shall be observed by the Architect. Work found to be in non compliance with the specifications shall be redone. The Architect shall be consulted for direction for questions regarding suitability of the installed work. The Architect shall be notified at least one week prior to the covering up of work so that observation of work may be scheduled. Work shall not be covered up or enclosed until work has been tested by Contractor and has been observed by proper authorities including State/local inspectors and Architect. Should work be covered up or enclosed before such observation or test, it shall be uncovered, tested and reviewed and shall be restored by Contractor to finished condition at Contractor's own expense.

F. Coordination:

1. Locations of devices, outlets, etc., as shown on the Drawings are approximate unless dimensioned or otherwise noted. Where locations of devices, outlets, etc., are dimensioned or noted on the Drawings, verify location with Architect's representative or with equipment to be supplied. Exact locations of devices, outlets, etc., shall be coordinated with field conditions. Ensure that switches or other electrical devices are mounted such that they are not "trapped" behind opened doors or otherwise rendered inaccessible, regardless of locations indicated on Drawings.

2. Where locations of devices and equipment are not specifically mentioned in the specifications or indicated on the Drawings, verify locations with Architect and Engineer prior to rough-in.

3. Prior to rough-in for service to equipment furnished or provided by others, coordinate with other trades and Owner to verify rough in locations, connection requirements, electrical service to equipment size and characteristics, and obtain a schedule of equipment electrical loads. Schedules shall be for verifying electrical services, controls, disconnects, fuses, and overload protection. Coordinate with Architect, authority having jurisdiction, and other appropriate Divisions as needed.

4. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Architect and Engineer prior to roughing in if conflicts appear. Be responsible for coordination of equipment to the available space and to the access routes through the construction. Confer and cooperate with other trades and coordinate the work in proper relation with theirs. Coordinate ceiling cavity space carefully with other trades.

G. Refer to Division 22 & 23 Mechanical and Plumbing drawings & specifications for coordination of electrical work with mechanical and plumbing work.

1. Unless otherwise noted, provide 120 volt wiring to nearest panelboard, including circuit breaker, conduit, wire and connections for new mechanical equipment control panels, and accessory equipment. Coordinate quantity and location with Division 23.

H. All ground or floor-mounted electrical distribution equipment, including switchboards, distribution panels, motor control centers, transfer switches, generators, and transformers, shall be installed and firmly anchored to a 4 inch high concrete housekeeping pad. Pad shall extend no more than 2 inches beyond the equipment footprint.

I. Interface With Other Work:

1. Unless otherwise noted, provide 120 volt wiring to nearest panelboard, including circuit breaker, conduit, wire, and connections for magnetic door holders, fire smoke dampers, and fire alarm system remote power supplies. Provide control circuitry from the fire alarm control panel. Coordinate quantity and location of fire smoke dampers with Division 23.

2. Other Communications Systems Raceways and Cable Supports: Provide a complete system of raceways, cable supports, and outlets for the future installation of a communications system.

a. Wall outlets shall be standard double gang boxes with single gang trim rings and cover plate of same design and finish as specified herein.

b. Cable supports in quantity and routing indicated shall be 2 inch diameter galvanized wide base CableCat J-hooks as manufactured by Caddy. Provide cable support mounting accessories as required.

c. Communication system raceway and cable support routing shall maintain 18 inches of clearance from luminaires while crossing perpendicular to lighting circuitry, maintain 12 inches clearance from power feeders and branch circuits, and maintain 4 feet clearance from motors and transformers. Conduits shall be sized as indicated or required with 3/4 inch as a minimum and include a #200 nylon pull cord. Conduit runs shall not have more than the equivalent of three 90 degree bends between outlets or pull boxes. Conduit ends shall be bushed.

3.5 REPAIR

A. Scratched, chipped, or otherwise marred electrical equipment shall be repainted to match original finish at no additional cost to the Owner.

3.6 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Arrange and oversee inspections by governing authorities. Upon completion of the work, deliver certificates of inspection and final approval to the Architect.

C. Testing of electrical systems shall be in accordance with the manufacturer's recommendations and in accordance with applicable codes and standards for that system as required and as referenced in this Specification.

D. Provide manufacturer's field representative to inspect as required and as referenced in this Specification.

E. Project site testing of equipment prior to installation, where called for in the specifications, shall include performance testing to establish the applicability of equipment for its intended purpose. Where required, Installer shall:

1. Establish required test procedures from required standard or manufacturer's recommendation.

2. Provide necessary test equipment, power, consumables to perform test.

3. Notify Architect and Engineer of test schedules at least one week in advance of testing.

4. Perform tests.

5. Provide necessary documentation to Architect and Engineer.

3.7 SYSTEM STARTUP

A. Final testing and start-up of electrical systems shall include the testing and checkout of equipment and systems to establish their proper capacity, operation, maintenance and code compliance. Where required, Installer shall:

1. Provide manufacturer's field representative to perform systems startup.

2. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

3. Provide necessary test equipment, power, consumables to perform tests.

4. Notify Architect of test ans start-up schedules at least one week in advance.

5. Provide necessary documentation of completed tests and fully functional systems to Architect.

B. Load balance test the distribution system. Unbalance between phases shall not exceed 10% with full lighting and mechanical loads. Correct unbalanced load conditions exceeding this limit. Corrections shall be indicated on Record Drawings.

3.8 ADJUSTING

A. Adjust for proper operation within manufacturer's published tolerances.

3.9 CLEANING

A. See Section 01 7419 - Construction Waste Management and Disposal, for additional requirements.

B. At the conclusion of each day's work, remove empty boxes, crates and rubbish and leave the area where the work has been done broom clean.

C. On completion of work, remove tools, scaffolding, debris, etc., from the grounds and leave the premises perfectly clean. Equipment and facilities shall be thoroughly cleaned inside and out and residue removed. Equipment shall be turned over to the Owner in perfect, unblemished condition. Remove temporary labels and stickers

3.10 COMMISSIONING

A. See Section 01 9113 - General Commissioning Requirements, for commissioning requirements.

B. See Section 26 0800 - Commissioning of Electrical Systems, for commissioning requirements in accordance with IECC.

C. See Section 26 0811 - Commissioning of Lighting and Lighting Controls Systems, for commissioning requirements in accordance with IECC.

3.11 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.

2. Briefly describe function, operation, and maintenance of each component.

E. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of two hours of training.

3. Instructor: Manufacturer's training personnel.

4. Location: At project site.

5. Location: Owner's offsite classroom facilities may be used.

F. Upon written request from the Contractor certifying that the work is complete and ready for inspection, the Engineer shall prepare punchlist of items determined to be incomplete or otherwise not in compliance with intent of Contract Documents.

G. When required, subsequent visit to review completion of punchlist work shall be made after receipt of written statement from Contractor indicating punchlist work is complete. Include copies of intermediate observation reports and final punchlists with individual items initialed by Contractor to attest that individual work items are completed.

H. Contractor shall pay Engineer's costs at the billing rates in effect at the time the services are performed for subsequent punchlist visits required due to lack of completion of prior punchlist.

3.12 PROTECTION

A. Protect installed materials and equipment from subsequent construction operations.

B. After tests and adjustments have been made and systems pronounced satisfactory for permanent operation, refinish damaged finish and leave everything in proper working order and of the intended appearance at the final completion of the Contract.

C. Reestablish original grades, landscaping, and other grade finishes.

3.13 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide testing and maintenance of equipment and systems per manufacturer’s requirements during warranty period to adhere to warranty requirements

END OF SECTION

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Nonmetallic-sheathed cable.

C. Service entrance cable.

D. Armored cable.

E. Metal-clad cable.

F. Wiring connectors.

G. Electrical tape.

H. Heat shrink tubing.

I. Oxide inhibiting compound.

J. Wire pulling lubricant.

K. Cable ties.

1.2 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0505 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.

C. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 2100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.

F. Section 28 4600 - Fire Detection and Alarm: Fire alarm system conductors and cables.

G. Section 31 2316 - Excavation.

H. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

I. Section 31 2323 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2015).

F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2016.

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

H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.

I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

J. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; 2012.

K. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.

L. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); 2007.

M. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.

N. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

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

P. UL 4 - Armored Cable; Current Edition, Including All Revisions.

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

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

S. UL 183 - Manufactured Wiring Systems; Current Edition, Including All Revisions.

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

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

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

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

X. UL 719 - Nonmetallic-Sheathed Cables; Current Edition, Including All Revisions.

Y. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.

Z. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the installation of direct burial cable with other trades to avoid conflicts with piping or other potential conflicts.
3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.

D. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.

E. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

F. Field Quality Control Test Reports.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 6000 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Wire and cable shall be provided and installed in accordance with the requirements of Section 26 05 00.

D. Installer Qualifications and Certifications: Firms with at least 3 years of successful installation experience with projects utilizing electrical wiring cabling work similar to that required for this project.

E. Manufacturer Qualifications: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

F. Regulatory Requirements: Conform to applicable code relations regarding toxicity of combustion products of insulating materials

G. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Wire and cable shall be delivered, stored and handled in accordance with the requirements of Section 26 05 00.

B. Deliver wire and cable properly packaged in factory-fabricated type containers or wound on NEMA-specified type wire and cable reels.

C. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

D. Handle wire and cable carefully to avoid abrading, puncturing, and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
   1. Exceptions:
      a. Use manufactured wiring systems for branch circuits where concealed under raised floors.
         1) Exception: Provide single conductor building wire in raceway for circuit homerun from distribution box to panelboard.
      b. Use power and control tray cable or metal-clad cable for installation in cable tray.

C. Nonmetallic-sheathed cable is permitted where allowed by code in type 5 construction.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is permitted where allowed by code in type 5 construction.

F. Armored cable is permitted only as follows:
   1. Where not otherwise restricted, may be used:
      a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

b. Where concealed in hollow stud walls and under raised floors for branch circuits up to 20 A.
   1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.

2. In addition to other applicable restrictions, may not be used:
   a. Unless approved by Owner.
   b. Where not approved for use by the authority having jurisdiction.
   c. Where exposed to view.
   d. Where exposed to damage.
   e. For damp, wet, or corrosive locations.
   f. For isolated ground circuits.

G. Metal-clad cable is permitted only as follows:
1. Where not otherwise restricted, may be used:
   a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
   b. Electrical feeders within rated electrical riser room.
   b. Where concealed in hollow stud walls and under raised floors for branch circuits up to 20 A.
      1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.

2. In addition to other applicable restrictions, may not be used:
   a. Unless approved by Owner.
   b. Where not approved for use by the authority having jurisdiction.
   c. Where exposed to view.
   d. Where exposed to damage.
   e. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.
   f. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide new conductors and cables manufactured not more than one year prior to installation.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

H. Conductors for Grounding and Bonding: Also comply with Section 26 0526.

I. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.

J. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.

K. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

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

M. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
   a. Exceptions:
      1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
      2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
      3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
2. Control Circuits: 14 AWG.
3. Wire sizes for other branch circuits shall be sized to limit voltage drop to 3%.

N. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

O. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
   a. 480Y/277 V, 3 Phase, 4 Wire System:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral/Grounded: Gray.
   b. 208Y/120 V, 3 Phase, 4 Wire System:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral/Grounded: White.
   e. Equipment Ground, All Systems: Green.
   f. Isolated Ground, All Systems: Green with yellow stripe.
   g. Travelers for 3-Way and 4-Way Switching: Pink.
   h. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
   i. For control circuits, comply with manufacturer's recommended color code.

P. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following (for each type of wire, cable, and connector):

1. Wire and cable:
    a. Triangle - PWC
    b. American Wire and Cable Co.
    c. Anaconda-Ericsson Inc; Wire and Cable Div.
    d. Belden Div; Cooper Industries
    e. General Cable Corporation
    f. General Electric
    g. Okonite
2. Connectors:
    a. O-Z/Gedney Co.
    b. AMP, Inc.
    c. Burndy Corporation
    d. Ideal Industries, Inc.
    e. 3M Company
    f. Thomas and Betts Corp.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
1. Feeders and Branch Circuits:
    a. Size 10 AWG and Smaller: Solid.
    b. Size 8 AWG and Larger: Stranded.
2. Control Circuits: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
    a. Size 4 AWG and Larger: Type XHHW-2.
    b. Installed Underground: Type XHHW-2.
    c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.
2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

2.4 ARMORED CABLE

A. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:
   1. Size 10 AWG and Smaller: Solid.
   2. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN.

E. Grounding: Combination of interlocking armor and integral bonding wire.
   1. Provide additional full-size integral insulated equipment grounding conductor for redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities.

F. Armor: Steel, interlocked tape.

2.5 METAL-CLAD CABLE

A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:
   1. Size 10 AWG and Smaller: Solid.
   2. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

E. Provide oversized neutral conductors where indicated or required.

F. Provide dedicated neutral conductor for each phase conductor where indicated or required.

G. Grounding: Full-size integral equipment grounding conductor.
   1. Provide additional isolated/insulated grounding conductor where indicated or required.

H. Armor: Steel, interlocked tape.

I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.6 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 0526.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors.
   3. Connectors for Aluminum Conductors: Use compression connectors.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.

2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Aluminum Conductors: Use compression connectors for all connections.
7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
8. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Ilsco: www.ilsco.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com/#sle.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Ilsco: www.ilsco.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com/#sle.

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
a. Burndy LLC: www.burndy.com/#sle.
b. Ilsco: www.ilsco.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com/#sle.

2.7 WIRING ACCESSORIES

A. Electrical Tape:
1. Manufacturers:
a. 3M: www.3m.com/#sle.
b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.
2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for

application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      b. Burndy LLC: www.burndy.com/#sle.
      c. Thomas & Betts Corporation: www.tnb.com/#sle.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
   1. Manufacturers:
      a. Burndy LLC: www.burndy.com/#sle.
      b. Ideal Industries, Inc: www.idealindustries.com/#sle.
      c. Ilsco: www.ilsco.com/#sle.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      b. American Polywater Corporation: www.polywater.com/#sle.
      c. Ideal Industries, Inc: www.idealindustries.com/#sle.

E. Cable Ties: Material and tensile strength rating suitable for application.
   1. Manufacturers:
      a. Burndy LLC: www.burndy.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
      a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
      b. Increase size of conductors as required to account for ampacity derating.
      c. Size raceways, boxes, etc. to accommodate conductors.
   8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
   9. Provide oversized neutral/grounded conductors where indicated and as specified below.
      a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
      b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install aluminum conductors in accordance with NECA 104.

E. Install armored cable (Type AC) in accordance with NECA 120.

F. Install metal-clad cable (Type MC) in accordance with NECA 120.

G. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

H. Exposed Cable Installation (only where specifically permitted):
   1. Route cables parallel or perpendicular to building structural members and surfaces.
   2. Protect cables from physical damage.

I. Direct Burial Cable Installation:
   1. Provide trenching and backfilling in accordance with Section 31 2316.13 - Trenching.
   2. Install cable with minimum cover of 24 inches unless otherwise indicated or required.
   3. Protect cables from damage in accordance with NFPA 70.

4. Provide underground warning tape in accordance with Section 26 0553 along entire cable length.

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

K. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

L. Terminate cables using suitable fittings.
1. Armored Cable (Type AC):
   a. Use listed fittings and anti-short, insulating bushings.
   b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
   c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.
2. Metal-Clad Cable (Type MC):
   a. Use listed fittings.
   b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
   c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

M. Install conductors with a minimum of 12 inches of slack at each outlet.

N. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

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

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

Q. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

R. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
   a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.

b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.

2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
   a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
   b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
3. Wet Locations: Use heat shrink tubing.

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

T. Identify conductors and cables in accordance with Section 26 0553.

U. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

V. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Chemically-enhanced ground electrodes.

G. Ground plate electrodes.

H. Ground enhancement material.

I. Ground access wells.

J. Pre-fabricated signal reference grids.

1.2 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

1. Includes oxide inhibiting compound.

B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 26 5600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.3 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

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

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

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify exact locations of underground metal water service pipe entrances to building.

2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.

3. For signal reference grids, coordinate the work with access flooring furnished in accordance with Section 09 6900.

4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Shop Drawings:

1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field quality control test reports.

F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.

2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

a. Provide continuous grounding electrode conductors without splice or joint.

b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

2. Metal Underground Water Pipe(s):

a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.

b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.

c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Metal In-Ground Support Structure:

a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

4. Concrete-Encased Electrode:

a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

5. Ground Ring:

a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than #4/0 CU in direct contact with earth, installed at a depth of not less than 30 inches.

b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.

c. Provide ground enhancement material around conductor where indicated.

d. Provide connection from ground ring conductor to:

1) Perimeter columns of metal building frame.

2) Ground rod electrodes located as indicated on electrical one-line diagram..

3) Lightning protection ground terminals around building perimeter. Refer to section 26 4113.

6. Ground Rod Electrode(s):

a. Provide single electrode unless otherwise indicated or required.

b. Space electrodes not less than 10 feet from each other and any other ground electrode.

c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.

d. Provide ground enhancement material around electrode where indicated.

e. Provide ground access well for each electrode.

7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.

   a. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.

   b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.

   c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

G. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.

2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:

1. Provide grounding electrode system for each separate building or structure.

2. Provide equipment grounding conductor routed with supply conductors.

3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.

4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:

   a. Transformers (except autotransformers such as buck-boost transformers).

   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.

c. Generators, when neutral is switched in the transfer switch.

2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.

3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.

4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.

5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.

6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.

7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.

2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.

3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.

4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:

a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

b. Metal gas piping.

c. Metal process piping.

8. Provide bonding for interior metal air ducts.

9. Provide bonding for metal building frame.

10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.

11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.

12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.

K. Isolated Ground System:

1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.

2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.

3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

L. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.

2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.

a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.

b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.

c. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.

d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

M. Signal Reference Grids:

1. Provide signal reference grid on subfloor under access floors where indicated.

2. Construct grid using field-welded sections of pre-fabricated signal reference grids.

3. Unless otherwise indicated, locate grid between 6 and 18 inches (150 and 450 mm) from perimeter walls.

4. Unless otherwise indicated, make bonding connections to signal reference grid using exothermic welded connections.

5. Make bonding connections as short as possible, with no sharp folds or bends.

6. Unless otherwise indicated, provide separate bonding connections from signal reference grid to each item to be bonded. Do not daisy chain items together to facilitate single point connection to signal reference grid.

7. Provide 6 AWG bonding jumper to connect every sixth access floor pedestal in each direction to signal reference grid. Make connections to floor pedestals using exothermic welded connections.

8. Provide 6 AWG bonding jumper to connect each steel column within and at the perimeter of room to signal reference grid. Make connections to steel columns using exothermic welded connections.

9. Provide 6 AWG bonding jumper to connect each metal item such as conduits, pipes, ducts, etc. crossing the plane of, or within 6 feet (1.8 m) of, the signal reference grid. Make connections to conduits and pipes using listed ground clamps.

10. Provide 6 AWG bonding jumper to connect signal reference grid to grounding point of separately derived systems serving equipment located on the signal reference grid.

11. Provide low impedance risers to connect each equipment enclosure to signal reference grid. For each piece of equipment, provide two separate connections of different lengths connected to opposite sides of equipment and to different points on the signal reference grid. Make connections to equipment enclosures using mechanical connectors. Do not make connection to signal reference grid on the outermost grid conductor.

12. Provide transient suppression plates on floor beneath items indicated. Provide 6 AWG bonding jumper to connect transient suppression plate to signal reference grid.

    a. Transient Suppression Plates: Constructed from 26 gage sheet copper, 4 by 4 feet unless otherwise indicated.

N. Pole-Mounted Luminaires: Also comply with Section 26 5600.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.

2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:

1. Use insulated copper conductors unless otherwise indicated.

    a. Exceptions:

        1) Use bare copper conductors where installed underground in direct contact with earth.

        2) Use bare copper conductors where directly encased in concrete (not in raceway).

2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gage of specified conductors.

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.

    a. Exceptions:

        1) Use mechanical connectors for connections to electrodes at ground access wells.

3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

    a. Exceptions:

        1) Use exothermic welded connections for connections to metal building frame.

4. Manufacturers - Mechanical and Compression Connectors:

    a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.

    b. Burndy LLC: www.burndy.com/#sle.

    c. Harger Lightning & Grounding: www.harger.com/#sle.

    d. Thomas & Betts Corporation: www.tnb.com/#sle.

5. Manufacturers - Exothermic Welded Connections:

    a. Burndy LLC: www.burndy.com/#sle.

    b. Cadweld, a brand of Erico International Corporation: www.erico.com/#sle.

    c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.

2. Size: As indicated.

3. Holes for Connections: As indicated or as required for connections to be made.

4. Manufacturers:

   a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.

   b. Erico International Corporation: www.erico.com/#sle.

   c. Harger Lightning & Grounding: www.harger.com/#sle.

   d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.

2. Material: Copper-bonded (copper-clad) steel.

3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.

5. Manufacturers:

   a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.

   b. Erico International Corporation: www.erico.com/#sle.

   c. Galvan Industries, Inc: www.galvanelectrical.com/#sle.

   d. Harger Lightning & Grounding: www.harger.com/#sle.

F. Chemically-Enhanced Ground Electrodes:

1. Description: Copper tube factory-filled with electrolytic salts designed to provide a low-impedance ground in locations with high soil resistivity; straight (for vertical installations) or L-shaped (for horizontal installations) as indicated or as required.

2. Length: 10 feet.

3. Integral Pigtail: Factory-attached, sized not less than grounding electrode conductor to be attached.

4. Backfill Material: Grounding enhancement material recommended by electrode manufacturer.

5. Manufacturers:

a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.

b. Erico International Corporation: www.erico.com/#sle.

c. Harger Lightning & Grounding: www.harger.com/#sle.

G. Ground Plate Electrodes:

1. Material: Copper.

2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.

3. Manufacturers:

a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.

b. Erico International Corporation: www.erico.com/#sle.

c. Harger Lightning & Grounding: www.harger.com/#sle.

H. Ground Enhancement Material:

1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.

2. Resistivity: Not more than 20 ohm-cm in final installed form.

3. Manufacturers:

a. Erico International Corporation: www.erico.com/#sle.

b. Harger Lightning & Grounding: www.harger.com/#sle.

I. Ground Access Wells:

1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.

2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.

a. Round Wells: Not less than 8 inches in diameter.

b. Rectangular Wells: Not less than 12 by 12 inches.

3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.

4. Cover: Factory-identified by permanent means with word "GROUND".

5. Manufacturers:

a. Advanced Lightning Technology (ALT: www.altfab.com/#sle.

b. Erico International Corporation: www.erico.com/#sle.

c. Harger Lightning & Grounding: www.harger.com/#sle.

J. Oxide Inhibiting Compound: Comply with Section 26 0519.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.

E. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.

3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

F. Identify grounding and bonding system components in accordance with Section 26 0553.

3.3 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 26 0526

SECTION 26 0533.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Intermediate metal conduit (IMC).

D. PVC-coated galvanized steel rigid metal conduit (RMC).

E. Flexible metal conduit (FMC).

F. Liquidtight flexible metal conduit (LFMC).

G. Electrical metallic tubing (EMT).

H. Rigid polyvinyl chloride (PVC) conduit.

I. Electrical nonmetallic tubing (ENT).

J. Liquidtight flexible nonmetallic conduit (LFNC).

K. Reinforced thermosetting resin conduit (RTRC).

L. Conduit fittings.

M. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 07 8400 - Firestopping.

C. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.

D. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1. Includes additional requirements for fittings for grounding and bonding.

E. Section 26 0529 - Hangers and Supports for Electrical Systems.

F. Section 26 0533.23 - Surface Raceways for Electrical Systems.

G. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

H. Section 26 2100 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

I. Section 27 1000 - Structured Cabling: Additional requirements for communications systems conduits.

J. Section 31 2316 - Excavation.

K. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

L. Section 31 2323 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2015.

C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A); 2015.

D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.

H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.

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

J. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005 (Reaffirmed 2013).

K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.

L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2016.

M. NEMA TC 13 - Electrical Nonmetallic Tubing (ENT); 2014.

N. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.

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

P. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

Q. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

R. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

S. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

T. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

U. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

V. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

W. UL 1653 - Electrical Nonmetallic Tubing; Current Edition, Including All Revisions.

X. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.

4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.

5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Shop Drawings:

1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.

2. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.

5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.

6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.

7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.

2. Within Slab Above Ground: Acceptable where allowed by structural engineer.

3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

1. Locations subject to physical damage include, but are not limited to:

a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

b. Where exposed below 20 feet in warehouse areas.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

M. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit, aluminum rigid metal conduit, or reinforced thermosetting resin conduit (RTRC).

1. Corrosive locations include, but are not limited to:

a. Cooling towers.

N. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), aluminum rigid metal conduit, or PVC-coated galvanized steel rigid metal conduit.

O. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

1. Maximum Length: 6 feet.

P. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.

2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.

3. Maximum Length: 6 feet unless otherwise indicated.

4. Vibrating equipment includes, but is not limited to:

a. Transformers.

b. Motors.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.2 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Electrical Service Conduits: Also comply with Section 26 2100.

C. Communications Systems Conduits: Also comply with Section 27 1000.

D. Fittings for Grounding and Bonding: Also comply with Section 26 0526.

E. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.

G. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 1/2 inch (16 mm) trade size.

2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.

3. Control Circuits: 1/2 inch (16 mm) trade size.

4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.

5. Underground, Interior: 3/4 inch (21 mm) trade size.

6. Underground, Exterior: 1 inch (27 mm) trade size.

H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com/#sle.

2. Republic Conduit: www.republic-conduit.com/#sle.

3. Wheatland Tube Company: www.wheatland.com/#sle.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Manufacturers:

a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.

4. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com/#sle.

2. Republic Conduit: www.republic-conduit.com/#sle.

3. Wheatland Tube Company: www.wheatland.com/#sle.

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:

1. Manufacturers:

a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.

4. Material: Use aluminum.

5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com/#sle.

2. Republic Conduit: www.republic-conduit.com/#sle.

3. Wheatland Tube Company: www.wheatland.com/#sle.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:

1. Manufacturers:

a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.

4. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.6 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Robroy Industries: www.robroy.com/#sle.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

D. Interior Coating: Urethane, minimum thickness of 2 mil.

E. PVC-Coated Fittings:

1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.

2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.

3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.

4. Material: Use steel or malleable iron.

5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.

6. Interior Coating: Urethane, minimum thickness of 2 mil.

F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.7 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com/#sle.

2. Electri-Flex Company: www.electriflex.com/#sle.

3. International Metal Hose: www.metalhose.com/#sle.

4. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:

1. Manufacturers:

a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

2.8 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com/#sle.

2. Electri-Flex Company: www.electriflex.com/#sle.

3. International Metal Hose: www.metalhose.com/#sle.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:

1. Manufacturers:

a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

2.9 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube & Conduit: www.alliedeg.com/#sle.

2. Republic Conduit: www.republic-conduit.com/#sle.

3. Wheatland Tube Company: www.wheatland.com/#sle.

4. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:

1. Manufacturers:

a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

c. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Material: Use steel or malleable iron.

a. Do not use die cast zinc fittings.

4. Connectors and Couplings: Use compression (gland) or set-screw type.

a. Do not use indenter type connectors and couplings.

5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

1. Cantex Inc: www.cantexinc.com/#sle.

2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.

3. JM Eagle: www.jmeagle.com/#sle.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.

2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.11 ELECTRICAL NONMETALLIC TUBING (ENT)

A. Manufacturers:

1. Cantex Inc: www.cantexinc.com/#sle.

2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.

B. Description: NFPA 70, Type ENT electrical nonmetallic tubing complying with NEMA TC 13 and listed and labeled as complying with UL 1653.

C. Fittings:

1. Manufacturer: Same as manufacturer of ENT to be connected.

2. Use solvent-welded type fittings.

3. Solvent-Welded Fittings: Rigid PVC fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; suitable for use with ENT.

4. Snap-on Fittings: Listed and labeled as complying with UL 651.

2.12 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:

1. AFC Cable Systems, Inc: www.afcweb.com/#sle.

2. Electri-Flex Company: www.electriflex.com/#sle.

3. International Metal Hose: www.metalhose.com/#sle.

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.13 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).

B. Supports: Per manufacturer's recommendations.

C. Fittings: Same type and manufacturer as conduit to be connected.

2.14 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

E. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

F. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

G. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

H. Install electrical nonmetallic tubing (ENT) in accordance with NECA 111.

I. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

J. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.

2. When conduit destination is indicated without specific routing, determine exact routing required.

3. Conceal all conduits unless specifically indicated to be exposed.

4. Conduit shall be run parallel to walls, ceilings, and building lines wherever possible.

5. Conduits in the following areas may be exposed, unless otherwise indicated:

a. Electrical rooms.

b. Mechanical equipment rooms.

c. Within joists in areas with no ceiling.

6. Unless otherwise approved, do not route conduits exposed:

a. Across floors.

b. Across roofs.

c. Across top of parapet walls.

d. Across building exterior surfaces.

7. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

8. Arrange conduit to maintain adequate headroom, clearances, and access.

9. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.

10. Arrange conduit to provide no more than 150 feet between pull points.

11. Route conduits above water and drain piping where possible.

12. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.

13. Maintain minimum clearance of 6 inches between conduits and piping for other systems.

14. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:

    a. Heaters.

    b. Hot water piping.

    c. Flues.

15. Group parallel conduits in the same area together on a common rack.

K. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.

2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.

4. Use conduit strap to support single surface-mounted conduit.

    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.

5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.

6. Use conduit clamp to support single conduit from beam clamp or threaded rod.

7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.

8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).

9. Use of spring steel conduit clips for support of conduits is not permitted.

10. Use of wire for support of conduits is not permitted.

    a. For securing conduits to studs in hollow stud walls.

    b. For suspending conduits supported by spring steel conduit clips (only where specifically indicated or permitted).

11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

L. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.

2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.

3. Use suitable adapters where required to transition from one type of conduit to another.

4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.

5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.

7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.

8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

M. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.

2. Make penetrations perpendicular to surfaces unless otherwise indicated.

3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.

4. Conceal bends for conduit risers emerging above ground.

5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.

6. Provide suitable modular seal where conduits penetrate exterior wall below grade.

7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.

9. Provide metal escutcheon plates for conduit penetrations exposed to public view.

10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

N. Underground Installation:

1. Provide trenching and backfilling in accordance with Section 31 2316.13.

2. Minimum Cover, Unless Otherwise Indicated or Required:

   a. Underground, Exterior: 24 inches.

   b. Under Slab on Grade: 12 inches to bottom of slab.

3. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.

O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 3000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

P. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

Q. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.

2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.

3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.

4. Where conduits are subject to earth movement by settlement or frost.

R. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.

2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

3. Where conduits penetrate coolers or freezers.

S. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

T. Provide grounding and bonding in accordance with Section 26 0526.

U. Identify conduits in accordance with Section 26 0553.

3.3 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 0553.13

SECTION 26 0533.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Boxes for hazardous (classified) locations.

D. Floor boxes.

E. Underground boxes/enclosures.

1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

B. Section 07 8400 - Firestopping.

C. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

D. Section 26 0526 - Grounding and Bonding for Electrical Systems.

E. Section 26 0529 - Hangers and Supports for Electrical Systems.

F. Section 26 0533.13 - Conduit for Electrical Systems:

1. Conduit bodies and other fittings.

2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

G. Section 26 0533.23 - Surface Raceways for Electrical Systems:

1. Accessory boxes designed specifically for surface raceway systems.

2. Lay-in wireways and wiring troughs with removable covers.

H. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

I. Section 26 2726 - Wiring Devices:

1. Wall plates.

2. Floor box service fittings.

3. Poke-through assemblies.

4. Access floor boxes.

5. Additional requirements for locating boxes for wiring devices.

J. Section 26 2813 - Fuses: Spare fuse cabinets.

K. Section 27 1000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

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

C. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

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

G. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

H. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.

4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.

5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

6. Coordinate the work with other trades to preserve insulation integrity.

7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.

8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

3. Provide products listed, classified, and labeled as suitable for the purpose intended.

4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.

2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.

4. Use cast aluminum boxes where aluminum rigid metal conduit is used.

5. Use nonmetallic boxes where exposed rigid PVC conduit is used.

6. Use suitable concrete type boxes where flush-mounted in concrete.

7. Use suitable masonry type boxes where flush-mounted in masonry walls.

8. Use raised covers suitable for the type of wall construction and device configuration where required.

9. Use shallow boxes where required by the type of wall construction.

10. Do not use "through-wall" boxes designed for access from both sides of wall.

11. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.

12. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.

13. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.

14. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.

15. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.

16. Minimum Box Size, Unless Otherwise Indicated:

a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.

b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.

c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.

17. Wall Plates: Comply with Section 26 2726.

18. Manufacturers:

    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.

    b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.

    c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.

    d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

    e. Thomas & Betts Corporation: www.tnb.com/#sle.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.

2. NEMA 250 Environment Type, Unless Otherwise Indicated:

    a. Indoor Clean, Dry Locations: Type 1, painted steel.

    b. Outdoor Locations: Type 3R, painted steel.

3. Junction and Pull Boxes Larger Than 100 cubic inches:

    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

    b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:

    a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.

    b. Back Panels: Painted steel, removable.

    c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.

5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

6. Manufacturers:

    a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.

    b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.

    c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.

D. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.

1. Manufacturers:

    a. Appleton, a brand of Emerson Electric Co: www.emerson.com/#sle.

    b. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.

    c. Hubbell Incorporated; Killark Products: www.hubbell-killark.com/#sle.

E. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 2726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.

2. Use cast iron floor boxes within slab on grade.

3. Use sheet-steel or cast iron floor boxes within slab above grade.

4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).

5. Manufacturer: Same as manufacturer of floor box service fittings.

F. Underground Boxes/Enclosures:

1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.

2. Size: As indicated on drawings.

3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.

4. Provide logo on cover to indicate type of service.

5. Applications:

    a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.

    b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 15 load rating.

    c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.

6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.

    a. Manufacturers:

        1) Hubbell Incorporated; Quazite Products: www.hubbellpowersystems.com/#sle.

        2) MacLean Highline: www.macleanhighline.com/#sle.

3) Oldcastle Precast, Inc: www.oldcastleprecast.com/#sle.

b. Combination fiberglass/polymer concrete boxes/enclosures are not acceptable. Use all-polymer concrete boxes/enclosures.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Pull and junction boxes shall be accessible.

E. Provide separate boxes for emergency power and normal power systems.

F. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

G. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

H. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

I. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.

2. Unless dimensioned, box locations indicated are approximate.

3. Locate boxes as required for devices installed under other sections or by others.

a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.

b. Communications Systems Outlets: Comply with Section 27 1000.

c. Communications outlets shall be mounted at the same height as adjacent receptacle outlets unless noted otherwise.

4. Locate boxes so that wall plates do not span different building finishes.

5. Locate boxes so that wall plates do not cross masonry joints.

6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.

7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.

8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.

9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.

    a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.

    b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.

10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.

11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:

    a. Concealed above accessible suspended ceilings.

    b. Within joists in areas with no ceiling.

    c. Electrical rooms.

    d. Mechanical equipment rooms.

J. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.

2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

K. Install boxes plumb and level.

L. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.

2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

M. Floor-Mounted Cabinets: Mount on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.

N. Install boxes as required to preserve insulation integrity.

O. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

P. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

Q. Underground Boxes/Enclosures:

1. Install enclosure on gravel base, minimum 6 inches deep.

2. Flush-mount enclosures located in concrete or paved areas.

3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.

4. Provide cast-in-place concrete collar constructed in accordance with Section 03 3000, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.

5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

R. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

T. Close unused box openings.

U. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

V. Provide grounding and bonding in accordance with Section 26 0526.

W. Identify boxes in accordance with Section 26 0553.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 0553.16

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Floor marking tape.

G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 26 0573 - Power System Studies: Arc flash hazard warning labels.

C. Section 26 2300 - Low-Voltage Switchgear: Factory-installed mimic bus.

D. Section 26 2726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

E. Section 27 1000 - Structured Cabling: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

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

D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.

2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

a. Switchgear:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Use identification nameplate to identify main and tie devices.

5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

b. Switchboards:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Use identification nameplate to identify main overcurrent protective device.

5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

c. Panelboards:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.

5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.

6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

d. Transformers:

1) Identify kVA rating.

2) Identify voltage and phase for primary and secondary.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Identify load(s) served. Include location when not within sight of equipment.

e. Enclosed switches, circuit breakers, and motor controllers:

1) Identify voltage and phase.

2) Identify power source and circuit number. Include location when not within sight of equipment.

3) Identify load(s) served. Include location when not within sight of equipment.

f. Busway:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Provide identification at maximum intervals of 40 feet.

5) Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.

g. Time Switches:

1) Identify load(s) served and associated circuits controlled. Include location.

h. Enclosed Contactors:

1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).

4) Identify coil voltage.

5) Identify load(s) and associated circuits controlled. Include location.

i. Transfer Switches:

1) Identify voltage and phase.

2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

3) Identify load(s) served. Include location when not within sight of equipment.

4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

j. Electricity Meters:

1) Identify load(s) metered.

2. Service Equipment:

a. Use identification nameplate to identify each service disconnecting means.

b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:

   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.

   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

   c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.

5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.

6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.

7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

8. Use identification label or identification nameplate on inside of door at each fused switch to identify required NEMA fuse class and size.

9. Use identification label or identification nameplate on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.

10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".

11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.

    a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 9123 and 09 9113.

12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.

    a. Service equipment.

    b. Industrial control panels.

c. Motor control centers.

d. Elevator control panels.

e. Industrial machinery.

13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.

    a. Minimum Size: 3.5 by 5 inches.

    b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

    c. Service Equipment: Include the following information in accordance with NFPA 70.

        1) Nominal system voltage.

        2) Available fault current.

        3) Clearing time of service overcurrent protective device(s).

        4) Date label applied.

14. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.

15. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

16. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

17. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

C. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.

2. Identification for Communications Conductors and Cables: Comply with Section 27 1000.

3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:

    a. At each source and load connection.

    b. Within boxes when more than one circuit is present.

    c. Within equipment enclosures when conductors and cables enter or leave the enclosure.

    d. In cable tray, at maximum intervals of 20 feet.

5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

6. Use underground warning tape to identify direct buried cables.

D. Identification for Raceways:

1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.

2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.

    a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.

        1) Color Code:

            a) Emergency Power System: Red.

            b) Fire Alarm System: Red.

        2) Field-Painting: Comply with Section 09 9123 and 09 9113.

        3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.

3. Use identification labels or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.

4. Use identification labels or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.

5. Use underground warning tape to identify underground raceways.

6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

E. Identification for Boxes:

1. Use voltage markers to identify highest voltage present.

2. Use voltage markers or color coded boxes to identify systems other than normal power system.

   a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.

      1) Emergency Power System: Red.

      2) Fire Alarm System: Red.

3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

   a. For exposed boxes in public areas, use only identification labels.

4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

F. Identification for Devices:

1. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.

2. Factory Pre-Marked Wallplates: Comply with Section 26 2726.

3. Use identification label to identify fire alarm system devices.

   a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.

4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.

   a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.

5. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

6. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

G. Identification for Luminaires:

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Manufacturers:

   a. Ideal Industries, Inc.

b. LEM Products, Inc.

c. Markal Corp.

d. Panduit Corp.

e. W.H. Brady, Co.

f. Substitutions: See Section 01 6000 - Product Requirements.

2. Materials:

a. Indoor Clean, Dry Locations: Use plastic nameplates.

b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.

3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.

a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.

4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.

6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:

a. Ideal Industries, Inc.

b. LEM Products, Inc.

c. Markal Corp.

d. Panduit Corp.

e. W.H. Brady, Co.

f. Substitutions: See Section 01 6000 - Product Requirements.

2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.

a. Use only for indoor locations.

3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.

2. Legend:

a. System designation where applicable:

1) Emergency Power System: Identify with text "EMERGENCY".

2) Fire Alarm System: Identify with text "FIRE ALARM".

b. Equipment designation or other approved description.

c. Other information as indicated.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height:

a. System Designation: 1 inch.

b. Equipment Designation: 1/2 inch.

c. Other Information: 1/4 inch.

d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.

5. Color:

a. Normal Power System: White text on black background.

b. Emergency Power System: White text on red background.

c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch by 2.5 inches.

2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 1/4 inch.

5. Color: Black text on white background unless otherwise indicated.

a. Exceptions:

1) Provide white text on red background for general information or operational instructions for emergency systems.

2) Provide white text on red background for general information or operational instructions for fire alarm systems.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.

2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 1/2 inch.

5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Power source and circuit number or other designation indicated.

a. Include voltage and phase for other than 120 V, single phase circuits.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Black text on clear background.

G. Format for Control Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Load controlled or other designation indicated.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.

2. Legend: Designation indicated and device zone or address.

3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 3/16 inch.

5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:

1. Brady Corporation: www.bradyid.com/#sle.

2. HellermannTyton: www.hellermanntyton.com/#sle.

3. Panduit Corp: www.panduit.com/#sle.

4. Substitutions: See Section 01 6000 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

1. Do not use handwritten text.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

A. Manufacturers:

1. Brady Corporation: www.bradyid.com/#sle.

2. Brimar Industries, Inc: www.brimar.com/#sle.

3. Seton Identification Products: www.seton.com/#sle.

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:

1. Markers for Equipment: 1 1/8 by 4 1/2 inches.

2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.

3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.

4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

E. Legend:

1. Markers for Voltage Identification: Highest voltage present.

2. Markers for System Identification:

a. Emergency Power System: Text "EMERGENCY".

F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Brady Corporation: www.bradyid.com/#sle.

2. Brimar Industries, Inc: www.brimar.com/#sle.

3. Seton Identification Products: www.seton.com/#sle.

B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

1. Exception: Use foil-backed detectable type tape where required by serving utility or where directed by Owner.

C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

D. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

E. Legend: Type of service, continuously repeated over full length of tape.

F. Color:

1. Tape for Buried Power Lines: Black text on red background.

2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 FLOOR MARKING TAPE

A. Manufacturers:

1. Brady Corporation: www.bradyid.com/#sle.

2. Brimar Industries, Inc: www.brimar.com/#sle.

3. Seton Identification Products: www.seton.com/#sle.

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

2.7 WARNING SIGNS AND LABELS

A. Manufacturers:

1. Brimar Industries, Inc: www.brimar.com/#sle.

2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.

3. Seton Identification Products: www.seton.com/#sle.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:

1. Materials:

a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.

b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.

2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.

3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.

a. Do not use labels designed to be completed using handwritten text.

2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.

3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.

2. Flush-Mounted Equipment: Inside of equipment door.

3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.

4. Elevated Equipment: Legible from the floor or working platform.

5. Branch Devices: Adjacent to device.

6. Interior Components: Legible from the point of access.

7. Conduits: Legible from the floor.

8. Boxes: Outside face of cover.

9. Conductors and Cables: Legible from the point of access.

10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 0553

SECTION 26 2413 - SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 2100 - Low-Voltage Electrical Service Entrance.

G. Section 26 2813 - Fuses: Fuses for fusible switches.

1. Includes requirements for spare fuses and spare fuse cabinets.

H. Section 26 4300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

D. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

E. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

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

G. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

I. UL 891 - Switchboards; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.

5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.

2. Include wiring diagrams showing all factory and field connections.

3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

4. Include documentation of listed series ratings.

5. Include documentation demonstrating selective coordination.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field Quality Control Test Reports.

F. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Enclosure Keys: Two of each different key.

3. Electronic Trip Circuit Breakers: Provide one portable test set.

4. Drawout Devices:

a. Handles Necessary for Racking of Devices: One for each electrical room containing switchgear with drawout devices.

b. Lifting Yokes: One of each different yoke required, for each electrical room containing drawout devices.

c. Portable Lifting Devices: One for each electrical room containing switchboards with drawout devices and no integral top rail-mounted lifting device.

d. Removable Covers: One for blocking each different opening size when device is temporarily removed from its compartment.

5. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Switchboards:

1. ABB/GE: www.geindustrial.com/#sle.

2. Eaton Corporation: www.eaton.com/#sle.

3. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

4. Siemens Industry, Inc: www.usa.siemens.com/#sle.

B. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Front-Connected Switchboards:

1. Main Device(s): Individually-mounted.

2. Feeder Devices: Panel/group-mounted.

3. Arrangement: Front accessible only (not rear accessible), rear aligned.

4. Gutter Access: Hinged doors.

E. Rear-Connected Switchboards:

1. Main Device(s): Individually-mounted.

2. Feeder Devices: Individually-mounted.

3. Compartmentalization: Provide barriered compartments for each overcurrent protective device, distribution bus, and rear cable connection area.

4. Arrangement: Rear accessible, front and rear aligned.

5. Rear Access: Bolted covers.

F. Service Entrance Switchboards:

1. Listed and labeled as suitable for use as service equipment according to UL 869A.

2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.

3. Comply with Utility Company requirements for electrical service.

4. Utility Metering Provisions: Provide separate barriered compartment complying with Utility Company requirements where indicated or where required by Utility Company. Include hinged sealable door and provisions for Utility Company current transformers (CTs), potential transformers (PTs), or potential taps as required.

5. See Section 26 2100 for additional requirements.

G. Service Conditions:

1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:

a. Altitude: Less than 6,600 feet.

b. Ambient Temperature:

1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.

2) Switchboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

H. Short Circuit Current Rating:

1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

I. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

J. Bussing: Sized in accordance with UL 891 temperature rise requirements.

1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.

2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.

3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

4. Phase and Neutral Bus Material: Aluminum.

5. Ground Bus Material: Aluminum.

K. Conductor Terminations: Suitable for use with the conductors to be installed.

1. Line Conductor Terminations:

a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

b. Main and Neutral Lug Type: Mechanical.

2. Load Conductor Terminations:

a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

b. Lug Type:

1) Provide mechanical lugs unless otherwise indicated.

L. Enclosures:

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).

b. Outdoor Locations: Type 3R.

2. Finish: Manufacturer's standard unless otherwise indicated.

3. Outdoor Enclosures:

a. Enclosure Type: Non-walk-in type unless otherwise indicated.

b. Color: Manufacturer's standard.

c. Access Doors: Lockable, with all locks keyed alike.

M. Future Provisions:

1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.

3. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.

N. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list switchboards as a complete assembly including surge protective device.

O. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.

a. Use zero sequence or residual ground fault detection method unless otherwise indicated.

b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

P. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

Q. Instrument Transformers:

1. Comply with IEEE C57.13.

2. Select suitable ratio, burden, and accuracy as required for connected devices.

3. Current Transformers: Connect secondaries to shorting terminal blocks.

4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Fusible Devices:

1. Fusible Switches:

a. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.

b. Fuse Clips: As required to accept indicated fuses.

1) Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

c. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

2. Fused Power-Circuit Devices:

a. Description: Quick-make, quick-break, dead-front bolted-pressure contact switches and high-pressure butt contact switches listed and labeled as complying with UL 977; ratings, configurations, and features as indicated on the drawings.

b. Bolted-Pressure Contact Switches: Devices with additional pressure or clamping action provided at both ends of switch blades when blades are in the fully closed position.

c. High-Pressure Butt Contact Switches: Devices with butt-type contacts and spring-charged mechanism.

d. Minimum Short Circuit Current Rating: 200,000 rms symmetrical amperes when protected by Class L fuses.

e. Fuse Clips: As required to accept Class L fuses.

f. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

g. Provide the following features and accessories where indicated or where required to complete installation:

1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

B. Circuit Breakers:

1. Interrupting Capacity:

a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.

2. Molded Case Circuit Breakers:

a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

1) Provide thermal magnetic circuit breakers unless otherwise indicated.

2) Provide electronic trip circuit breakers where indicated.

b. Minimum Interrupting Capacity:

1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.

2) 14,000 rms symmetrical amperes at 480 VAC.

c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

2) Provide interchangeable trip units where indicated.

d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

1) Provide the following field-adjustable trip response settings:

a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

b) Long time delay.

c) Short time pickup and delay.

d) Instantaneous pickup.

e) Ground fault pickup and delay where ground fault protection is indicated.

e. Provide the following circuit breaker types where indicated:

1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.

2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

f. Provide the following features and accessories where indicated or where required to complete installation:

1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

3. Insulated Case Circuit Breakers:

a. Description: Quick-make, quick-break, trip-free circuit breakers with two-step stored energy closing mechanism; standard 80 percent rated unless otherwise indicated; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

b. Operation:

1) Provide manually operated circuit breakers unless otherwise indicated.

2) Provide electrically operated circuit breakers where indicated.

3) Pad-Lock Provision: For preventing circuit breaker closing operation.

c. Construction:

1) Provide fixed-mount circuit breakers unless otherwise indicated.

2) Provide drawout circuit breakers where indicated.

d. Drawout Circuit Breakers:

1) Allows withdrawal of circuit breaker into test and disconnected positions, with racking position indication (connected, test, disconnected, withdrawn).

2) Provide safety interlock to prevent racking of circuit breaker while in the ON position.

3) Pad-Lock Provision: For preventing circuit breaker drawout operation.

e. Minimum Interrupting Capacity:

1) 42,000 rms symmetrical amperes at 240 VAC or 208 VAC.

2) 65,000 rms symmetrical amperes at 480 VAC.

f. Trip Units: Solid state, microprocessor-based, true rms sensing.

1) Provide the following field-adjustable trip response settings:

a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

b) Long time delay.

c) Short time pickup and delay.

d) Instantaneous pickup.

e) Ground fault pickup and delay where ground fault protection is indicated.

g. Provide the following circuit breaker types where indicated:

1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.

2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

h. Provide the following features and accessories where indicated or where required to complete installation:

1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2.4 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:

1. Dielectric tests.

2. Mechanical operation tests.

3. Grounding of instrument transformer cases test.

4. Electrical operation and control wiring tests, including polarity and sequence tests.

5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.

E. Provide required support and attachment components in accordance with Section 26 0529.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.

H. Provide grounding and bonding in accordance with Section 26 0526.

I. Install all field-installed devices, components, and accessories.

J. Provide fuses complying with Section 26 2813 for fusible switches as indicated.

K. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 0573.

M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

N. Provide filler plates to cover unused spaces in switchboards.

O. Identify switchboards in accordance with Section 26 0553.

3.3 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

C. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

D. Inspect and test in accordance with NETA ATS, except Section 4.

E. Perform inspections and tests listed in NETA ATS, Section 7.1.

F. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

G. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

H. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

I. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

J. Test shunt trips to verify proper operation.

K. Correct deficiencies and replace damaged or defective switchboards or associated components.

L. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

A. See Section 01 7419 - Construction Waste Management and Disposal, for additional requirements.

B. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

C. Repair scratched or marred surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

3.7 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 26 2413

SECTION 26 2416 - PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 2200 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.

G. Section 26 2813 - Fuses: Fuses for fusible switches and spare fuse cabinets.

H. Section 26 4300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

F. NEMA PB 1 - Panelboards; 2011.

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

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

J. UL 67 - Panelboards; Current Edition, Including All Revisions.

K. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.

2. Include wiring diagrams showing all factory and field connections.

3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

4. Include documentation of listed series ratings upon request.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Panelboard Keys: Two of each different key.

3. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

2. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Nameplate information shall include catalog number or factory order number, date of manufacturing, UL Listed label, ampere, voltage, phase, and AIC ratings.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.

2. Ambient Temperature:

a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

b. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

D. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.

3. Label equipment utilizing series ratings as required by NFPA 70.

E. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

G. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

H. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.

2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.

3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Boxes: Galvanized steel unless otherwise indicated.

a. Provide wiring gutters sized to accommodate the conductors to be installed.

b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.

c. Provide removable end walls for NEMA Type 1 enclosures.

d. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.

3. Fronts:

a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

K. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

L. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list and label panelboards as a complete assembly including surge protective device.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.

a. Use zero sequence ground fault detection method unless otherwise indicated.

b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

O. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

P. Load centers are not acceptable.

Q. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.

2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase and Neutral Bus Material: Aluminum or copper.

2. Ground Bus Material: Aluminum.

D. Circuit Breakers:

1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.

2. Provide thermal magnetic circuit breakers unless otherwise indicated.

3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:

1. Provide surface-mounted enclosures unless otherwise indicated.

2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

3. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

4. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Aluminum or copper.

3. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.

2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Fusible Switches:

1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.

2. Fuse Clips: As required to accept indicated fuses.

    a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

4. Conductor Terminations:

    a. Provide mechanical lugs unless otherwise indicated.

    b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

B. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:

    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

        1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.

        2) 14,000 rms symmetrical amperes at 480 VAC.

    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

    c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.

3. Conductor Terminations:

    a. Provide mechanical lugs unless otherwise indicated.

    b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

    a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

    b. Provide interchangeable trip units where indicated.

5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

    a. Provide the following field-adjustable trip response settings:

        1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

        2) Long time delay.

        3) Short time pickup and delay.

        4) Instantaneous pickup.

        5) Ground fault pickup and delay where ground fault protection is indicated.

6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

7. Provide the following circuit breaker types where indicated:

    a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

    b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.

    c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.

    d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.

    e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.

10. Do not use tandem circuit breakers.

11. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

12. Provide the following features and accessories where indicated or where required to complete installation:

    a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

    b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

13. Dwelling Units:

    a. Arc-Fault Circuit-Interrupter Protection. Arc-fault circuit-interrupter protection shall be provided as required in NEC 210.12(A), (B), and (C). The arc-fault circuit interrupter shall be installed in a readily accessible location.

    b. Arc-Fault Circuit-Interrupter Protection shall be providedon all 120-volt, single-phase, 15- and 20 ampere branch circuits supplying outlets or devices installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas.

2.6 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. The fire rated listing or integrity of walls in which flush mounted panelboards are installed shall be maintained.

D. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

F. Provide required supports in accordance with Section 26 0529.

G. Install panelboards plumb.

H. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

I. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

J. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.

K. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

L. Provide grounding and bonding in accordance with Section 26 0526.

1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.

2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

M. Install all field-installed branch devices, components, and accessories.

N. Provide fuses complying with Section 26 2813 for fusible switches as indicated.

O. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

P. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

Q. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.

R. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

S. Provide filler plates to cover unused spaces in panelboards.

T. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:

1. Emergency and night lighting circuits.

2. Fire detection and alarm circuits.

3. Communications equipment circuits.

4. Intrusion detection and access control system circuits.

5. Video surveillance system circuits.

U. Identify panelboards in accordance with Section 26 0553.

V. Directory cards shall be completely filled out with all circuits adequately marked and shall be typewritten. Room numbers shall be confirmed prior to completion. Spares shall be marked "SPARE". Spaces shall be marked "SPACE".

W. Provide facilities for future connection of additional loads. Two 1 inch spare conduits shall be stubbed out above ceiling or run to an accessible location from each flush mounted branch circuit panelboard. Two 2 inch spare conduits shall be stubbed out above ceiling or run to an accessible location from each flush mounted distribution panelboard.

3.3 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

E. Test GFCI circuit breakers to verify proper operation.

F. Test AFCI circuit breakers to verify proper operation.

G. Test shunt trips to verify proper operation.

H. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2416

SECTION 26 2726 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Wall dimmers.

C. Receptacles.

D. Wall plates.

E. Floor box service fittings.

F. Poke-through assemblies.

1.2 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0533.16 - Boxes for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).

D. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.

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

F. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

G. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

H. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

I. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

J. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.

K. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.

3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.

4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.

5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.

6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1. Wall Dimmers: Include derating information for ganged multiple devices.

2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.

C. Operation and Maintenance Data:

1. Wall Dimmers: Include information on operation and setting of presets.

2. GFCI Receptacles: Include information on status indicators.

3. Surge Protection Receptacles: Include information on status indicators.

D. Project Record Documents: Record actual installed locations of wiring devices.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide listed tamper resistant receptacles for receptacles, non-locking, 15 and 20 ampere installed in dwelling units per NEC 406.12.

E. Provide listed tamper resistant receptacles for receptacles, non-locking, 15 and 20 ampere installed in guest rooms and guest suites of hotels per NEC 406.12.

F. Provide listed tamper resistant receptacles for receptacles, non-locking 15 and 20 ampere installed in child care facilities per NEC 406.12.

G. Provide GFCI protection for receptacles installed within 6 feet of sinks.

H. Provide GFCI protection for receptacles installed in kitchens.

I. Provide GFCI protection for receptacles serving electric drinking fountains.

J. Unless noted otherwise, do not use combination switch/receptacle devices.

K. For flush floor service fittings, use tile rings for installations in tile floors.

L. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.2 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.

C. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.

D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.

E. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

F. Isolated Ground Convenience Receptacles: Orange.

G. Surge Protection Receptacles: Blue.

H. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

I. Clock Hanger Receptacles: Brown with stainless steel wall plate.

J. Above-Floor Service Fittings: Gray wiring devices with satin aluminum housing.

K. Flush Floor Box Service Fittings: Gray wiring devices with aluminum cover and ring/flange.

L. Flush Poke-Through Service Fittings: Gray wiring devices with aluminum cover and aluminum flange.

M. Access Floor Boxes: Gray wiring devices with gray steel cover with insert to match floor covering.

2.3 WALL SWITCHES

A. Manufacturers:

1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

2. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with decorator style rocker type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Commercial specification grade, 20 A, 120/277 V with illuminated decorator style rocker type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Commercial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Commercial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Commercial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking Momentary Contact Wall Switches: Commercial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.4 WALL DIMMERS

A. Manufacturers:

1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.

3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

C. Dimmer switches shall be coordinated with lamps and ballasts shown to be dimmed. Ensure compatibility between dimmer switch and ballast, lamp type or LED driver within fixture.

D. Control: Slide control type with separate on/off switch.

E. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:

1. Incandescent: 600 W.

2. Magnetic Low-Voltage: 600 VA.

3. Electronic Low-Voltage: 400 VA.

4. Fluorescent: 600 VA.

F. Provide locator light, illuminated with load off.

G. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.5 RECEPTACLES

A. Manufacturers:

1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

2. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.

3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

4. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.

2. NEMA configurations specified are according to NEMA WD 6.

3. Hospital Grade Receptacles: Listed as complying with UL 498 Supplement SD, with green dot hospital grade mark on device face.

C. Convenience Receptacles:

1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.

2. Automatically Controlled Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.

3. Isolated Ground Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.

4. Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

5. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.

6. Tamper Resistant and Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

7. Illuminated Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; illuminated face or indicator light to indicate power is being supplied to receptacle; single or duplex as indicated on the drawings.

D. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

a. Provide test and reset buttons of same color as device.

2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

4. Tamper Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

5. Tamper Resistant and Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

E. USB Charging Devices:

1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.

a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.

b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.

2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

3. USB Charging Noncombination Devices: Four-port (Type A); rectangular decorator style.

F. Surge Protection Receptacles:

1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 1449, Type 2 or 3.

a. Energy Dissipation: Not less than 240 J per mode.

b. Protected Modes: L-N, L-G, N-G.

c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.

d. Diagnostics:

1) Visual Notification: Provide indicator light to report functional status of surge protection.

2. Standard Surge Protection Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. Isolated Ground Surge Protection Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, with ground contacts isolated from mounting strap.

G. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

H. Clock Hanger Receptacles: Single, 15A, 125V, NEMA 5-15R.

2.6 WALL PLATES

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.

2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

3. Lutron Electronics Company, Inc: www.lutron.com/#sle.

4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

B. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.

2. Size: Standard;

3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

E. Aluminum Wall Plates: Smooth satin finish, clear anodized, factory-coated to inhibit oxidation.

F. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

G. Weatherproof Covers for Wet or Damp Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

1. Thomas & Betts: #CKLSVU(1-gang) and #2CKU (2-gang) or equal.

2.7 POKE-THROUGH ASSEMBLIES

A. Manufacturers:

1. Thomas & Betts Corporation: www.tnb.com/#sle.

2. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

C. Flush Floor Service Fittings:

1. Dual Service Flush Combination Outlets:

a. Cover: Hinged door(s).

b. Configuration:

1) Power: One standard convenience duplex receptacle(s).

2) Voice and Data Jacks: Provided by others.

2. Dual Service Flush Furniture Feed:

a. Configuration:

1) Power: One 3/4 inch threaded opening(s).

2) Communications: Two 1/2 inch threaded opening(s).

3. Accessories:

a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that floor boxes are adjusted properly.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

G. Verify that core drilled holes for poke-through assemblies are in proper locations.

H. Verify that openings in access floor are in proper locations.

I. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:

a. Wall Switches: 48 inches above finished floor.

b. Wall Dimmers: 48 inches above finished floor.

c. Fan Speed Controllers: 48 inches above finished floor.

d. Receptacles: 18 inches above finished floor or 6 inches above counter.

2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

3. Receptacles over-counter shall be mounted horizontally.

4. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

5. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

6. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Where receptacles are installed within one stud spacing width from a switch, the convenience outlet and switch shall align vertically.

D. Install wiring devices in accordance with manufacturer's instructions.

E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

I. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

J. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.

K. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

L. Install wiring devices plumb and level with mounting yoke held rigidly in place.

M. Install wall switches with OFF position down.

N. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

O. Do not share neutral conductor on branch circuits utilizing wall dimmers.

P. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

Q. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

R. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

S. Identify wiring devices in accordance with Section 26 0553.

T. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

U. Match receptacles and special purpose outlets to Owner-furnished equipment, unless otherwise indicated. Coodinate receptacle Nema configuation with Owner-furnished equipment plug requirements.

3.4 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Inspect each surge protection receptacle to verify surge protection is active.

G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 2726

SECTION 26 2813 - FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fuses.

B. Spare fuse cabinet.

1.2 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

B. Section 26 0573 - Power System Studies: Additional criteria for the selection of protective devices specified in this section.

C. Section 26 2413 - Switchboards: Fusible switches.

D. Section 26 2816.16 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

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

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.

E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.

F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.

G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.

    a. Fusible Switches for Switchboards: See Section 26 2413.

    b. Fusible Enclosed Switches: See Section 26 2816.16.

2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.

3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1. Spare Fuse Cabinet: Include dimensions.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Extra Fuses: One set(s) of three for each type and size installed.

3. Fuse Pullers: One set(s) compatible with each type and size installed.

4. Spare Fuse Cabinet Keys: Two.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.

B. Littelfuse, Inc: www.littelfuse.com/#sle.

C. Mersen: ep-us.mersen.com/#sle.

2.2 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

1. Class RK1, Time-Delay Fuses:

2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:

3. Class RK5, Time-Delay Fuses:

4. Class RK5, Fast-Acting, Non-Time-Delay Fuses:

H. Class J Fuses: Comply with UL 248-8.

1. Class J, Time-Delay Fuses:

2. Class J, Fast-Acting, Non-Time-Delay Fuses:

I. Class L Fuses: Comply with UL 248-10.

1. Class L, Time-Delay Fuses:

2. Class L, Fast-Acting, Non-Time-Delay Fuses:

J. Class T Fuses: Comply with UL 248-15.

K. Class CC Fuses: Comply with UL 248-4.

1. Class CC, Time-Delay Fuses:

2. Class CC, Fast-Acting, Non-Time-Delay Fuses:

L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

M. Provide the following accessories where indicated or where required to complete installation:

1. Fuseholders: Compatible with indicated fuses.

2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

2.3 SPARE FUSE CABINET

A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.

B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that mounting surfaces are ready to receive spare fuse cabinet.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

C. Install spare fuse cabinet in convenient location in main electrical room unless otherwise indicated.

D. Identify spare fuse cabinet in accordance with Section 26 0553.

END OF SECTION 28 2813

SECTION 26 2816.16 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 0573 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.

E. Section 26 2813 - Fuses.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

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

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.

2. Include wiring diagrams showing all factory and field connections.

D. Project Record Documents: Record actual locations of enclosed switches.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.

2. See Section 26 2813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.

2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available

fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

2. Minimum Ratings:

a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.

b. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.

c. Double Throw Switches Protected by Class R, Class J, or Class T Fuses: 100,000 rms symmetrical amperes.

G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

H. Provide with switch blade contact position that is visible when the cover is open.

I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

M. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

O. Heavy Duty Switches:

1. Comply with NEMA KS 1.

2. Conductor Terminations:

a. Provide mechanical lugs unless otherwise indicated.

b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

a. Provide means for locking handle in the ON position where indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 0529.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Provide fuses complying with Section 26 2813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Identify enclosed switches in accordance with Section 26 0553.

3.3 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2816.16

SECTION 26 4300 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

B. Surge protective devices for distribution locations.

C. Surge protective devices for branch panelboard locations.

1.2 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 2300 - Low-Voltage Switchgear.

C. Section 26 2413 - Switchboards.

D. Section 26 2416 - Panelboards.

E. Section 26 2419 - Motor-Control Centers.

F. Section 26 2513 - Low-Voltage Busways.

1.3 ABBREVIATIONS AND ACRONYMS

A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.

B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

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

D. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.6 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

F. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

G. Project Record Documents: Record actual connections and locations of surge protective devices.

1.7 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:

1. Advanced Protection Technologies, Inc (APT): www.aptsurge.com/#sle.

2. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com/#sle.

3. Schneider Electric; Square D Brand Surgelogic Products: www.surgelogic.com/#sle.

4. www.vertivco.com (formerly Liebert).

B. Factory-installed, Internally Mounted Surge Protective Devices:

1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.2 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Protected Modes:

1. Wye Systems: L-N, L-G, N-G, L-L.

C. UL 1449 Voltage Protection Ratings (VPRs):

1. Equivalent to basis of design.

D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

E. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

1. Indoor clean, dry locations: Type 1.

2. Outdoor locations: Type 3R.

F. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.

1. Switchgear: See Section 26 2300.

2. Switchboards: See Section 26 2413.

3. Panelboards: See Section 26 2416.

4. Motor Control Centers: See Section 26 2419.

5. Busway Plug-in Units: See Section 26 2501.

2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.

E. Repetitive Surge Current Capacity: Not less than 5,000 impulses.

F. UL 1449 Nominal Discharge Current (I-n): 20 kA.

G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

H. Diagnostics:

1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.

2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

I. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.4 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Distribution locations include SPDs connected to distribution panelboards, motor control centers, and busway.

D. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

E. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.

F. Repetitive Surge Current Capacity: Not less than 3,500 impulses.

G. UL 1449 Nominal Discharge Current (I-n): 20 kA.

H. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

I. Diagnostics:

1. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.

2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

J. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.5 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.

E. Repetitive Surge Current Capacity: Not less than 2,000 impulses.

F. UL 1449 Nominal Discharge Current (I-n): 20 kA.

G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

H. Diagnostics:

1. Protection Status Monitoring: Provide indicator lights to report the protection status.

2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

I. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

E. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

F. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

H. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.3 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

3.4 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 4300

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESIGN REQUIREMENTS

A. Provide equipment supports rated for the supported loads.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Conduit Hangers: Galvanized steel with special accessories for purpose and adequate to support load imposed.

B. Coatings: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance-using NEMA/UL approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

C. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, and wall brackets.

D. Fasteners: Types, materials, and construction features as follows:
1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.

E. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for no armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

G. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

H. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
1. One-Hole Conduit Straps or Minerallac: For supporting 3/4 inch and smaller conduit, galvanized steel.
2. Two-Hole Conduit Straps or Minerallac or industry approved equal: For supporting 1 inch and larger conduit, galvanized steel; 3/4 inch strap width; and 2-1/8 inch between center of screw holes.

I. Fabricated Supporting Devices:
1. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
2. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

3. Pipe Sleeves: Provide pipe sleeves of one of the following:
   a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint.
   b. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
      1) 3-inch and Smaller: 20 gauge
      2) 4-inch to 6-inch: 16 gauge
      3) Over 6-inch: 15 gauge
   c. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
   d. EMT, IMC, or Rigid Conduit.

J. J-Hooks and Bridle Rings
   1. J-hooks and bridle rings maybe used to support low voltage wiring systems.

K. The following are prohibited.
   1. Plastic or fiber anchors.
   2. Drilling or structured steel members.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Conduit Hangers: Support individual conduit 1-1/2 inch and larger and all multiple conduit runs with hangers. Clamp conduits individually to each support.

B. Supports and Hangers:
   1. Support and align all raceways, cabinets, boxes, fixtures, etc., in an accepted manner and as herein specified. Support raceways on accepted types of wall brackets, specialty steel clips or hangers, ceiling trapeze hangers or malleable iron straps. Provide lead expansion shields in concrete, machine screws, bolts or welding on metal surfaces, and wood screws on wood construction. Use of powder-driven studs is prohibited without express permission from the University Project Manager.
      a. Mount all conduits to structure a minimum of 7 inches above any accessible type ceiling, or with spacing as required to permit relocation of recessed fixtures to any location.
   2. Structural and post tensioned concrete members shall not be drilled or pierced without prior approval from the University Project Manager.
   3. Where outlets are installed in steel stud type systems, provide additional cross bracing, bridging and/or straps as required to make outlet completely rigid prior to application of wall facing material.
   4. Design hangers and wall brackets so that maximum deflection will be no greater than 1/8 inch.
   5. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
   6. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with the NEC and the following requirements:
   1. Conform to manufacturer's recommendations for selection and installation of supports.
   2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.
   3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
   4. Use of ceiling support wires is unacceptable.
   5. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8-inch diameter or larger threaded steel rods for support. Threaded rod shall be covered by ½ inch conduit from bottom of (trapeze) support to 6-inches above cable tray.

6. Support individual horizontal raceways by separate pipe hangers.
7. Space supports for raceways in accordance with NEC.
8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom double nut. Remove sharp edges.

D. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panel boards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

E. In open overhead spaces, support metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an engineer approved type of fastener not more than 24 inches from the box.

F. Sleeves: Install in walls and all other fire-rated floors and walls for raceways and cable installations as required. Where sleeves through floors are installed, extend above finish floor. For sleeves through fire rated-wall or floor construction, apply UL listed fire stopping sealant in gaps between sleeves and enclosed conduits and cables. See Engineering plans for location and extent of fire rated assemblies.

G. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, bus ways, cabinets, panel boards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Powder-driven studs are not acceptable. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25% of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

H. Telecommunications Systems Cable Supports: Use cable tray or telecommunications approved cable supports.

END OF SECTION 26 05 29

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESIGN REQUIREMENTS

A. Underground Electrical Primary:
1. Service (primary) – Main Campus primary distribution is owned by the university. Assume all systems are ungrounded in cable standards.
2. Unless otherwise stated during the pre-design conference, the university will provide and underground junction point or switch point within the contract limits (or close by) for termination of primary building feeder. Contractor will provide and install raceway and conductors between said junction point and the building transformer.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Underground Electrical Primary:
1. Duct Bank (primary): Concrete encase underground 13.8 kV raceway. Raceway may be P.V.C. Type 1 or equivalent. Concrete envelope shall be red color and shall be a minimum of 4 inch all around cover. (Example: 4-inch raceway would require 12 inch cross section of concrete).
2. Primary Cable: 15 kV class cable to be single copper conductor, 220 mil insulated for ungrounded type service, shielded, 90 degree C rated, with copper conductor cable.
3. Ground: No. 4 AWG with THWN 600 volt insulation copper wire in raceway with primary service to building. Tie said ground wire to common system ground of building.
4. All conduits entering or exiting buildings shall be hull wall rigid metal conduit to minimize future shearing of conduits. After leaving building excavation, the transaction to other types of conduits can be made.
5. Warning tape shall be buried 6 inches deep on top of buried electrical and control wiring. The tape shall be inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. The tape shall be 3 inches wide, colored Red and imprinted with “CAUTION: BURIED ELECTRIC LINE BELOW”.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Underground Electrical Primary:
1. Install duct in accordance with manufacturer’s recommendations. Install duct at depth and locations as indicated on drawings. Install duct with a minimum slope of 4 inches per 100 feet. Slope duct away from building. Provide suitable fittings to accommodate expansion and deflection.
2. Band ducts together before placing concrete. Securely anchor to prevent movement during placing of concrete. Stagger duct joints vertically in concrete encasement. Provide two (2) - #4 steel reinforcing bars in top of bank under paved areas.
3. Swab duct. Use suitable caps to protect installed duct.
4. Install cable and accessories in accordance with manufacturer’s instructions.
5. Avoid abrasion and other damage to cable during installation. Use suitable lubricants and pulling equipment. Do not exceed cable pulling tensions and bending radius.
6. Ground cable shield at each termination and splice.
7. Install cables in manholes along wall providing longest route. Arrange cable in manholes to avoid interference with duct entrances. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing on inch into duct.

8. Provide PVC coated rigid conduit for all 90 degree elbows.

END OF SECTION 26 05 43

SECTION 26 20 00 - LOW VOLTAGE ELECTRICAL DISTRIBUTION

PART 1 - GENERAL

1.1 DESIGN REQUIREMENTS

A. Motors, Starters and Protection: Electrical contractor will supply and install all motor controllers and disconnect switches.

B. Panelboards:
1. Provide a minimum of four (4) – 3/4" spare conduits out of panels. Run empty conduit to accessible spaces and label conduits as spare.
2. All lighting and power panels will be specified to provide minimum of 30% spare capacity and spare breaker space.
3. A/E will provide panel indexes on contract drawings. Final indexes to be provided and installed by the Contractor will correspond to final university room number schedule.
4. The switching of lights from lighting panels is acceptable only if specifically approved by the university CBO, through the University Project Manager; and if approved, a separate panel will be provided for circuits, which are to be controlled. No circuits other than lighting will originate in the panel thus provided. In the rare instance of lights being switched by breaker, provide switch-rated breakers.

C. Grounding and Testing: Transformer neutrals of separately derived systems secondaries will be grounded by way of a grounding conductor between the secondary neutral and grounding buss at the main service entrance equipment. Size determined in accordance with NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cartridge Fuses:
   a. Bussmann Div., Cooper Industries, Inc.
   b. Littelfuse Inc.
   c. Or equal
2. Fusible Switches:
   a. Square D Co.
   b. Allen-Bradley Co.
   c. General Electric Co.
3. Eaton-Cutler HammerMolded-Case Circuit Breakers:
   a. Square D Co.
   b. General Electric Co.
   c. Siemens Energy & Automation, Inc.
   d. Eaton-Cutler HammerABB Power Distribution, Inc.
4. Combination Circuit Breaker and Ground Fault Circuit Interrupters:
   a. Square D Co.
   b. General Electric Co.
   c. Siemens Energy & Automation, Inc.
5. Eaton-Cutler HammerSafety Switches:
   a. Siemens – Energy Automation Or equal
6. Motor Starters:
   a. Allen-Bradley Co.
7. Panelboards:
   a. General Electric Co. Siemens – Energy Automation

b. Square D
c. Eaton-Cutler Hammer
d. Panelboards shall match existing throughout facility in remodel situations.

8. Motor Control Centers:
   a. Allen - Bradley
   b. ITE
   c. GE
   d. Square D
   e. Westinghouse/Cutler Hammer

2.2 MATERIALS, GENERAL

A. Motor Starters:
1. Shall be combination circuit breaker (magnetic only) full voltage magnetic type with 3-leg overload protection in NEMA I enclosure. Provide 2 interlock contacts of interchangeable open-close type. Provide hand-off automatic selector, motor running transformer type red LED pilot light and reset button in cover. Control circuits shall be provided with individual 120-volt control transformers. Starters shall be furnished under electrical contract. Size starts as required by NEC.
2. Starters for fractional horsepower (1/2 HP or less) 120-volt motors shall be manual type, unless shown otherwise, equipped with built-in overload protection. All magnetic starters shall be of one manufacturer. For all thermal overload switches provide General Electric type CR101 or equal of other acceptable manufacturer.
3. All motors larger than 1/2 HP shall be 3 phase.
4. Motors above 25 HP will require step starting or VFDs to limit starting current.
5. All motors to be provided with external overload running protection. This is in addition to any 'built-in' protection inherent in the motor.
6. All motors of 1-1/2 HP and larger shall be of a high or premium efficient type and have an efficiency of not less than those values as stated in the IEEE test procedures, 112A Method B.

B. Panelboards:
1. Panelboards shall be bolt on, circuit breaker type. Panelboard bus shall be copper and shall be size to meet the continuous and short circuit rating as shown on the drawings.
2. All panel covers will be factory painted with low gloss enamel (not flat wall paint) suitable for metal. No field painting will be permitted. Toggle type covers not acceptable.
3. Panelboards shall be of door-in-door construction.
4. Panelboards shall be fully rated. The use of Series rated panelboards is prohibited.
5. Non linear land panelboards shall be provided in areas with heavy computer boards or laboratory equipment leads. These panelboards shall be provided with 200% neutrals.

C. Power Factor Correction: All motors 20 HP and larger will be power factor corrected to a minimum of 95% at design load. HVAC systems may be corrected at the motor control center.

D. Over current Protective Device:
1. General: Provide OCPDs in indicated types, as integral components of panelboards, switchboards, motor control centers, and other related equipment; and also as individually enclosed and mounted single units.
2. Where OCPDs are to be installed in existing panelboards, switchboards, and motor control centers, they shall be of the same manufacture and type as those existing in the equipment.

E. Cartridge Fuses:
1. General: Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage consistent with the circuits on which used.
2. All fuses used for main, feeder, or branch-circuit protection shall be UL listed, current limiting fuses with 200,000 ampere interrupting rating and shall be so labeled. Fuses used for supplementary protection (other than branch circuit protection) shall be as specified above or shall be UL approved or component recognized for such purposes. The same manufacturer shall furnish

all fuses provided. Should equipment provided require a different UL class or size of fuse, the engineer shall be furnished sufficient data to ascertain that system function will not be adversely affected.

3. Fuses over 600 amperes shall be UL Class "L" fuses; and shall have minimum time-delay of 10 seconds at 500% rating.
4. To simplify fuse replacement, reduce spare fuse inventory and insure adequate thermal protection, all fuses 600 amperes and below shall be true dual-element time-delay fuses with separate spring-loaded thermal overload elements in all ampere ratings. All ampere ratings shall be designed to open at 400 degree F or less when subjected to a non-load oven test.
5. To eliminate induction heating, all fuse ferrules and end caps shall be non-ferrous and shall be bronze or other alloy not subject to stress cracking.
6. Class L Fuses: UL 198C, "High-interrupting Capacity Fuses, Current-limiting Type."
7. Class RK1 and RK5 Dual Element Time-delay Fuses: UL 198E, "Class R Fuses."

F. Fusible Switches:
1. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS-1 "Enclosed Switches," quick-make, quick-break, heavy-duty units.
2. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.
3. Withstand Capability: In excess of the let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.
4. Operation: By means of external handle.
5. Interlock: Prevents access to switch interior except when in "off" position.
6. Fuse Clips: Rejection type.
7. Padlocking Provisions: For 2 padlocks whether open or closed.
8. Enclosure for Switchboard or Panel board Mounting: Suitable for panel mounting where indicated.
9. Enclosure for Switchboard Mounting: Provide individual mounting where indicated.
10. Enclosure for Independent Mounting: NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.
11. Contacts shall be NEMA rated 75 degree C.
12. Provide fuses for safety switches and other equipment of classes, types, and rating needed to fulfill electrical requirements for services indicated.
13. Provide auxiliary contacts for disconnects supplied from variable frequency drives.

G. Safety Switches:
1. Heavy-duty type, horsepower rated for motors. Quick-make, Quick-break, load interrupter enclosed knife switch with externally operable handle. Handle shall be lockable in the "off" position.
2. Standard enclosure NEMA 1 indoors and NEMA 3R weather-tight outdoors.

H. Molded-case Circuit Breakers:
1. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."
2. Construction: Bolt-in type breakers.
3. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating of 10,000 amperes symmetrical for 120 and 208 volt devices and 14,000 amperes symmetrical for 277 and 480 volt devices, unless a greater rating is indicated or required to match existing devices or equipment.
4. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous over current trip protection for each pole.
5. Solid State Molded Case Circuit Breakers: Provide with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip, instantaneous trip and adjustable short time and long time. The instantaneous shall be capable of being turned on and off on the main service breaker only.
6. Enclosure for Switchboard or Panel board Mounting: Suitable for panel mounting in switchboard or panel boards where indicated.

7. Enclosure for Switchboard or Motor Control Center Mounting: Provide individual mounting where indicated.
8. Enclosure for Independent Mounting: NEMA Type 1 enclosure, except as otherwise indicated or required to suit environment where located.

I. Combination Circuit Breakers and Ground Fault Circuit Interrupters: UL 943, "Ground Fault Circuit Interrupters," arranged for sensing and tripping for ground fault current in addition to over current and short-circuit current. Provide features as follows:
1. Match features and module size of panel board breakers and provide clear identification of ground fault trip function.
2. Trip Setting for Ground Fault: Recalculate / reset as required by additional loads in excess of 100A @ 480v 3-phase.

J. Distribution Switchboard:
1. NEMA PB 2 with electrical ratings and configurations as indicated. Main section shall be individually mounted. Distribution devices shall be group mounted. Provide for future provisions.
2. Bus material shall be copper and shall be fully insulated. Bus connections shall be bolted and shall be accessible from the back. Ground bus shall run the entire length of the switchboard.
3. Line and Load Terminations: Accessible from the front. Suitable for the conductor size and type shown.
4. Ground Fault Sensor: Zero sequence type.
5. Align sections in front. Switchboard height shall be 90 inches. Finish shall be manufacturer's standard light gray. Mimic bus shall be provided.

K. Motor Control Center
1. NEMA ICS 2, Class II Type A, B or C. Voltage and current ratings shall be as shown on the drawings. Enclosure shall be NEMA ICS 6 Type 1 or 2.
2. Main over current protection shall be molded case circuit breaker sized as shown on the drawings.
3. Vertical and horizontal bus shall be copper and rated as shown on drawings.

L. Secondary Substation: Secondary substations are prohibited without prior approval from the university facilities.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Maintenance Stock Fuses: Refer to Section 01 78 46 – Extra Stock Materials.

B. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions.

C. OCPDs in distribution and branch circuit equipment shall be factory installed.

D. Connections: Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

E. Grounding: Provide equipment-grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

F. Panel boards:

1. Except as otherwise noted, locate panel boards as follows: Dimensions given are from finished floor.
   a. 6'-6" to top of trim.
2. Contractors who are modifying or installing new electrical panels must redo the panel directory making the directory current. In the case of a new panel, the panel directory must coincide with actual (correct) building room numbers. Panel schedules need to be updated when extra circuits are added or when the entire panel is upgraded, such as with remodel jobs. Final directory shall be typed, hand written directories are not acceptable.
3. Only one wire per breaker will be allowed.
4. Wire shall be neatly formed to contour with the panel box. Remove all excess wire lengths.
5. Every panel shall have a grounding bar installed in its interior. Attached to the grounding bar shall be a grounding conductor taken to earth ground and/or a domestic water copper or metal pipe when appropriate as required by NEC.
6. An energized panel shall not be left exposed or unlocked to the general public, such as in a hallway, office, or other pedestrian walkway. Panel covers shall be reinstalled at the end of the workday.
7. Attach panel boards to concrete walls or floors with a concrete type anchor approved for the purpose that requires drilling of the concrete and manually driving in the anchor by force. Do not use powder-actuated or plastic anchors to secure panel boards. Do not use horizontally approved anchors for vertical applications.
8. Panel identification is imperative. The panel shall be identified on the outside of the panel cover per Section 26 05 53.
9. Panel cover hardware shall be replaced if broken or not operating properly.
10. Breakers shall be labeled odd numbers on left side; even numbers on right side.
11. Match existing building equipment wherever possible and/or coordinate with the University Project Manager.
12. Provide externally mounted TVSS units for all Information Technology panels.

G. Switchboards:
   1. Install switchboard on 4-inch housekeeping pad. Install switchboards in accordance with manufacturer's recommendations. Tighten bus connections after placing switchboard.
   2. Coordinate size of switchboard with door openings and access corridors to assure that switchboards can be moved after structure is complete.

H. Motor Control Centers (MCC): Install MCC on 3-inch housekeeping pad. Install MCC in accordance with manufacturer's recommendations.

I. Electrical panels, switchgear, and any kind of electrical distribution boards shall not be worked hot.

J. All mechanical ductwork and piping not directly serving the electrical room shall be prohibited in electrical room. All plumbing piping, and storm drains are prohibited to be routed through electrical rooms.

K. Provide a framed record drawing of the complete and final electrical distribution one-line. Mount in the main electrical room.

L. Secondary Unit Substation:
   1. Install 3-inch housekeeping pad for unit substation.
   2. Install in accordance with drawings and manufacturer’s instructions.

END OF SECTION 26 20 00

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 DESIGN PERFORMANCE

A. Size transformers based on calculated load plus 20% spare capacity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptance Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Cutler Hammer
   2. Siemens
   3. General Electric
   4. Square D

2.2 MATERIALS, GENERAL

A. Description: Transformers shall be NEMA ST 20, factory assembled, air cooled, altitude corrected, copper wound dry-type distribution transformers of sizes, characteristics and ratings indicated, designed to supply a 100% nonlinear load. Winding taps per NEMA ST 20.

B. Transformers shall have 220 degree C, Class H insulation. All transformers shall be rated for 115 degree C maximum temperature rise above 40 degrees C ambient.

C. Provide ventilated drip-proof, conventional type metal housings for indoor service. Provide all necessary supports, rods, and hangars to properly and securely support transformer in location indicated.

D. All windings shall be of high quality copper.

E. Winding Taps:
   1. Transformers Less than 15 kVA: Two 5% below rated voltage, full capacity taps on primary winding.
   2. Transformers 15 kVA and Larger: NEMA ST 20.
   3. Transformers shall have 480 volt, 3 phase, 3 wire primary and 120/208 volt, 3 phase, 4 wire, 60 hertz, wye connected secondary unless otherwise noted.

F. Sound Levels: Maximum sound levels are as follows: NEMA ST 20.

G. Basic Impulse Level: 10 kV for transformers.

H. Ground core and coil assembly to enclosure by means of a visible flexible copper-grounding strap.

I. Mounting: Mount on 4” housekeeping pad.

J. Coil Conductors: Continuous windings with terminations brazed or welded.

K. Enclosure: NEMA ST 20; Type 1, ventilated. Provide lifting eyes or brackets.

L. Transformers shall be supplied with factory installed internal vibration absorbing isolators to isolate core and coil from enclosures.

M. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install transformer in accordance with manufacturer's instructions.

B. Set transformer on house keeping pad plumb and level. Suspended transformers are prohibited without prior approval from the University Project Manager.

C. Use flexible conduit, under the provisions of Section 26 05 33 2ft (0.6 M) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure, bottom entry is not acceptable.

D. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

E. Bond transformer according to Article 250 of the NEC.

END OF SECTION 26 22 00

SECTION 26 33 53 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 DESIGN REQUIREMENTS - UPS MODULE

A. Voltage. Input/output voltage of the UPS:
1. Rectifier Input: 208 volts, three-phase, 4-wire-plus-ground
2. Bypass Input: 208 volts, three-phase, 4-wire-plus-ground
3. Output: 208 volts, three-phase, 4-wire-plus-ground

B. Output Load Capacity. Provide output load capacity at unity factor.

C. Scalable Output Capacity. UPS rated output capacity will be determined by design engineer.

1.2 DESIGN REQUIREMENTS – BATTERY

A. Battery Cells: Valve-regulated, lead acid batteries.

B. Reserve Time: 15 minutes.

C. Recharge Time: to 95% capacity within ten (10) times discharge time.

1.3 PERFORMANCE REQUIREMENTS

A. Voltage Configuration for Standard Units: 208V, three-phase, four-wire plus ground.

B. Voltage Range: +15%, -20% of nominal without derating.

C. Inrush Current: UPS inrush current not to exceed 1.5 times rated input current. Maintenance bypass and distribution cabinet inrush current not to exceed 8 times rated input current.

D. Current Limit: 140% of nominal AC input current maximum.

E. Current Distortion: <3% reflected THD maximum at full load.

F. Surge Protection: Sustains input surges without damage per criteria listed in IEC 1000-4-5.

G. Voltage Regulation:
1. ±1% three-phase RMS average for a balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor
2. ±5% three-phase RMS average for a 100% unbalanced load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor

H. Frequency Slew Rate: Selectable from 0.1Hz/sec to 3.0Hz/sec maximum for single unit.

I. Phase Balance:
1. 120 degrees ±1 degree for balanced load
2. 120 degrees ±1.5 degrees for 100% unbalanced load

J. Voltage Distortion:
1. <1% total harmonic distortion (THD) for linear loads
2. <5% THD for 100% nonlinear loads (3:1 crest factor) without kVA/kW derating

K. Load Power Factor Range: 0.7 lagging to 0.9 leading without derating.

L. Overload Capability:
1. 110% for 60 minutes
2. 125% for 10 minutes
3. 150% for 60 seconds

M. Voltage Transient Response: 100% load step, ±5.0%.

N. Transient Recovery Time: to within 5% of steady state output voltage within half a cycle.

O. Voltage Unbalance: 100% unbalanced load, ±5%.

P. Locate UPS in a conditioned space.

Q. Altitude: Provide UPS rating based on altitude derating factors.

1.4 MANUFACTURER QUALIFICATIONS

A. A minimum of 20 years' experience in the design, manufacture and testing of solid-state UPS systems is required. The system shall be designed and manufactured according to world-class quality standards.

1.5 PROVIDE FACTORY TESTING PRIOR TO PRODUCT SHIPMENT.

PART 2 - PRODUCTS

2.1 FABRICATION

A. Materials
1. Physically isolated control logic and fuses from power train components to ensure operator safety and protection from heat. All electronic components shall be accessible from the front without removing sub-assemblies for service access.

B. Wiring
1. All electrical power connections shall be torqued to the required value and marked with a visual indicator.
2. Provide tin-plated copper busbars.

C. Cooling
1. Provide cooling capacity as needed to maintain manufacturer's recommended operating temperature for the UPS and batteries.

2.2 COMPONENTS

A. General
1. Provide on line, double conversion UPS.

B. DC Filter
1. Provide DC filter with adequate capacity to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter without the battery connected.

2.3 INVERTER

A. Overload Capability
1. Provide inverter be capable of supplying current and voltage for overloads exceeding 100% up to 150%. The UPS shall transfer the load to bypass when overload capacity is exceeded.

B. Voltage Distortion
1. Total harmonic distortion in the output voltage will not exceed 1% for 0% to 100% linear loads.
2. Total harmonic distortion in the output voltage will not exceed 4% for 0% to 100% non-linear loads.
3. Total harmonic distortion in the output voltage will not exceed 5% for 0% to 100% non-linear, unbalanced loads.

2.4 DISPLAY AND CONTROLS

A. Monitoring and Control
1. Provide microprocessor/graphical status display and controls. A graphical shall be used to show a single-line diagram of the UPS and shall be provided as part of the monitoring and controls sections of the UPS. Locate operator controls and monitors on the front of the UPS cabinet display. Monitoring functions such as metering, status and alarms on the graphical display. Additional features of the monitoring system shall include:
    a. Menu-driven display with pushbutton navigation
    b. Real-time clock (time and date)
    c. Alarm history with time and date stamp
    d. Memory with battery backup

B. Metering
1. Display the following parameters:
    a. Input AC voltage line-to-line
    b. Input AC current for each phase
    c. Input frequency
    d. Battery voltage
    e. Battery charge/discharge current
    f. Output AC voltage line-to-line
    g. Output AC current for each phase
    h. Output frequency
    i. Apparent power
    j. Active power
    k. Battery time left during battery operation

C. Alarm Messages
1. Display the following alarm messages:
    a. Mains Voltage Abnormal
    b. Mains Undervoltage
    c. Mains Freq. Abnormal
    d. Charger Fault
    e. Battery Reversed
    f. No Battery
    g. Control Power 1 Fail
    h. Parallel Comm. Fail
    i. Bypass Unable To Track
    j. Bypass Abnormal
    k. Inverter Asynchronous
    l. Fan Fault
    m. Control Power 2 Fail
    n. Unit Over Load

o. System Over Load
p. Bypass Phase Reversed
q. Transfer Time-Out
r. Load Sharing Fault
s. Bypass Over Current
t. Output Ground Fault

D. Status Messages
1. Display the following UPS status messages:
a. Rectifier (Off / Soft Start / Main Input On / Battery Input On)
b. Input Supply (Normal Mode / Battery Mode / All Off)
c. Battery Self Test (True / False)
d. Input Disconnect (Open / Closed)
e. EPO (True / False)
f. Charger (On / Off)
g. Output Disconnect (Open / Closed)
h. Maint. Disconnect (Open / Closed)
i. Bypass Disconnect (Open / Closed)
j. Inverter (Off / Soft Start / On)
k. Bypass (Normal / Unable To Trace / Abnormal)
l. Output Supply (All Off / Bypass Mode / Inverter Mode / Output Disable)
m. Inverter On (Enable / Disable)

E. On-Line Battery Test
1. Provide the UPS with a menu-driven On-Line Battery Test feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode.

2.5 STATIC TRANSFER SWITCH

A. General
1. Provide a static transfer switch and bypass circuit as an integral part of the UPS.

2.6 BATTERY POWER PACK

A. Provide the battery power pack valve-regulated, lead-acid battery cells housed in a separate cabinet that matches the UPS cabinet styling to form an integral system lineup. Provide battery cells on slide-out trays for ease of maintenance. Provide a battery disconnect circuit breaker for isolation of the battery pack from the UPS module.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide central UPS circuits for power feeding facilities Building Automation System (BAS) control panels. Circuiting building user loads to this UPS is not acceptable.

B. Provide central UPS circuits for power feeding animal facility lighting control computer and control panels associated with watering systems, robotics, cage wash, mechanical systems, etc.

C. During the design process, coordinate with the facilities department any additional building systems required to be connected on the UPS.

END OF SECTION 26 33 53

SECTION 28 31 00 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 DESIGN REQUIREMENTS

A. Provide a micro computer based system using multiplex techniques for alarm reporting, central monitoring, signaling, and selection of audible and visual signal circuits. The fire alarm system should be capable of making emergency announcements. The fire alarm subcontractor should work closely with the campus Information technology department working through the University Project Manager to make this work.

B. Provide individually identified fire alarm sensors; pull stations, indicating devices, and compatible monitor and control devices. Provide a unique address for each device 8 digit only, with operator-assigned English language descriptor.
   1. The system shall include the following major components
      a. Fire Alarm Control Panel
         1) CU Anschutz buildings – Edwards EST3
         2) CU Denver buildings – Edwards EST3
         3) CU Denver buildings on Auraria Higher Education Campus – Verify with Project Manager.
      b. Fire Alarm Annunciator Panel (FAAP) and LCD Display.
      c. Fire Alarm Voice/Evacuation Panel (FVEP)
      d. Fire Alarm Computer Terminal (FACT) – FACT refers to the individual building and University Police Building FACT.
         4) CU Anschutz buildings – FireWorks
         5) CU Denver buildings – FireWorks for Edwards fire alarm systems
         6) CU Denver buildings on Auraria Campus – Verify with Project Manager.
      e. Fireman Two Way Telephone Panel (FTP) – If required by the building type.
      f. Digital Alarm Communicator Transmitter (DACT) (3-Mod Comp)
      g. Interface with campus overhead Emergency Paging system with Central Station monitoring computer controls.
   2. Conventional fire alarm initiating devices (smoke detectors, heat detectors, manual stations, water flow and tamper switches, pressure switches) shall each be individually addressable via, and shall report to the FACP.
   3. Control relays shall be individually commanded by the system to respond automatically in case of an alarm by related sensors or other devices. Manual control of fans, dampers and required relays shall be provided, as well as automatic control where required by code. Control sequences shall be as indicated on related mechanical systems control drawings.

C. The system shall operate as a low voltage, zone-annunciated Fire Management System and shall include the following subsystems:
   1. FACP to monitor addressable initiating and control devices, annunciate the alarm device exact location, initiate alarm and evacuation signals, and capture and recall elevators.
   2. FACP and Associated Auxiliary panels shall be provided with Class “A” wiring.

D. Provide UL listed system. If required as a condition requisite to establishing UL listing of the entire installation as a system, the Contractor shall arrange for, and pay all costs associated with, any required off-site or on-site review, supervision, and/or inspection which may be required for gaining such UL listing.

E. Conform to the following NFPA requirements:
   1. Initiating Device Circuits (IDC) shall be Class B
   2. The Signaling Line Circuits (SLC) shall be configured as follows:

a. Class A for signaling line circuits connecting intelligent devices to the FACP.
b. Loss of connectivity between FACP and the facility's Central Control FACP shall not hamper functions of the fire alarm system within the building.

3. The Notification Appliance Circuit (NAC) shall be Class B

F. ANSCHUTZ MEDICAL CAMPUS SYSTEM LAYOUT
1. General:
a. All campus buildings will be equipped with a FACP. Locate near the main entry and a FVEP located near the FACP per the building design, for all non high-rise buildings.
b. Each FACP shall be networked into the campus network and accessible from the Campus FACT. Any FVEP shall be accessed from the Campus FCC FVEP microphone and/or the Campus Police Station FVEP microphone.
c. One FACP and FACT in one university high-rise building FCC and one university high-rise building FCC will be designated alternate locations for the Campus FCC FACP. All information residing in the FACP/FACT of the Campus will be duplicated at these two locations.
d. A FACT with FAP or a FAAP with LCD indicating building in alarm shall be located at the University Police Building. The Police Station shall be capable of accessing any FVEP via local microphone.
e. Every building will be equipped with a weatherproof speaker/strobe located at each exterior door.
f. Include the Following Front Panel Controls:
1) Each floor shall have a disable button
2) Elevator disable
3) Fan/shut-down disable
4) Pager disable
5) Door disable
6) Separate speaker and strobe disable
7) Manual page by floor
8) NETCOM DISABLE
9) BAS DISABLE

G. Provide interface with the Building Automation System to report all “alarm” and “supervisory” actions. Refer to Division 23.

1.2 PERFORMANCE REQUIREMENTS

A. General:
1. Normal operator interface, through the FACP located in each individual building where required, and at the designated FACT located in the Anschutz Medical Campus University Police Building in the Police Dispatch. All system early-warning pre-alarm, alarm, and trouble messages shall be annunciated on the FACT in a color-graphic format with English language descriptors.

B. High-Rise Buildings.
1. The fire alarm sequence of operation shall be in accordance with the requirements for high-rise buildings, including but not limited to the following:
a. The alarm and activate the strobes for the floor in alarm and the floors above and below.
b. Initiate stair pressurization and where used, initiate pressurization of the floors above and below the floor in alarm.
c. Release of stair, held-open doors, and re-entry doors.
d. Upon activation of the elevator, elevator shafts, or elevator lobby detectors, recall the elevators to the main exit level or alternate floor.
e. Activate refuge area communications link.
f. Annunciate the alarm to the building FACP, and FAAP, and to University Police FACT.
g. Annunciate the alarm condition and location to the building FAAP and local floor FAAP.
2. The Command Center of the High Rise Buildings shall also be equipped, under another contract, with the following remote status/control panels:
a. Buildings electrical distribution system.
b. Building fire pump.

c. Elevator status and control panel.
d. Building voice paging system and/or voice evacuation system (i.e., Office Building) via zone interface panel and microphone.
e. CCTV system monitors and keyboard.
f. Smoke control panel.
g. Generator control panel.

3. The FD will use these panels for viewing or controlling each of the above systems.

C. The FD will respond to the FACP of the building in alarm and to the Campus Police. The Campus Police FACT shall be automatically activated into the graphics mode to show the current status of all devices in alarm. The FD will take command of the Building's FACT to monitor the current response to the fire alarm condition. Using a "mouse driven" graphic menu, the FD shall be able to "zoom in" or "zoom out" of the graphic screens to view the current alarm condition.

1. The FD will use the building's FCC PC graphic system to view and control the response of the fire alarm system by viewing special graphic screens such as:
   a. A smoke control system status and control screen.
   b. Any building within the complex connected to the fire alarm system.
   c. Any preprogrammed screen existing within the fire alarm system.
   d. Or other specialty screens that may be created at the request of the university Facilities Operations.
2. Using the assigned FD Identification Code (ID password), the FD may use the FCC PC to alter the preprogrammed fire fighting response to the present alarm condition. A printer will provide hard copy documentation of all alarm conditions, ID password log on commands, and the system response to the specific fire alarm condition.

D. The Campus Control Center fire alarm computer will provide monitoring and secondary back up of the fire alarm computers located in the various fire command centers. If an equipment trouble alarm is initiated from a fire alarm device, it shall be reported at the FCC FACP of the building in alarm and the Campus Control Center PC.

E. If a fire alarm condition is received and the FD cannot initiate an appropriate response from the building's FCC PC (i.e., fire in the Buildings' FCC room, or a failure of the FCC PC), then an override ID password command can be used by the FD to make any system PC the primary PC for the manual fire fighting override response. The selected PC shall be able to alter a building's preprogrammed response to the alarm condition. The selected PC shall be able to access and control all PC graphic screens that reside within the system.

F. It shall be possible for all authorized personnel, using the proper ID password, to place the facility into smoke control operation through the graphic screens from the University Police (FACT), or the Building's FCC FACP.

G. Automatic Actions:

1. Activation of an alarm-initiating device, as specified herein shall cause the following:
   a. Annunciation of the alarm condition, type, and device address at the FACP, FACT and FAAP in a LCD format at the building FAAP. An audible signal shall sound and the alarm condition shall flash until acknowledged. The alarm condition and its location shall also be displayed at the University Police FACP, FACT, and FAAP per the building design.
   b. The appropriate audio and visual alarms shall be transmitted throughout the building in alarm or to predetermined zones of the building in alarm.
   c. Disable the elevator call system and recall the elevators to the level of discharge exit or to the alternate floor.
   d. Initiate smoke control procedures and functions automatically (position dampers and control fans) from the building FACP.
   e. Release self-closing fire and smoke doors in specified control zone when the system goes into alarm.
   f. Provide control relay at each access control panel to unlock all secured doors in activated

control zone.

University Project Manager.

2. Provide smoke detector circuits with alarm verification with field-adjustable time from 0 to 60 seconds. Only verified alarms shall initiate the specified sequences.
3. Activation of a sprinkler valve supervisory switch shall initiate supervisory alarm at the corresponding building FACP, FAAP, FACT, and FAP and initiate a supervisory alarm signal at the University Police FACT. Supervisory alarms shall be differentiated from a trouble condition on the circuit.
4. A break in the initiating circuit or detector power wiring shall be annunciated as a trouble condition on the building FACP and the University Police FACT.
5. A break in the audio/visual circuit wiring shall be annunciated as a trouble condition on the building FACP and the University Police FACT.

H. Failsafe Operation: To increase the system's ability to survive damage from fire, malicious or accidental damage, premature component failure, etc., the fire alarm system shall provide the following functionality:
1. Each building FACP shall operate in a stand-alone manner, independent of any other FACP or FACT. The building FACP shall contain the complete data file for all connected devices, regardless of the building, and shall operate the same way whether connected to any other FACP or FACT. This includes:
   a. Annunciation of device address and condition. One hundred percent of all connected devices shall be capable of operating for alarm simultaneously.
   b. Logical Point Grouping annunciation and control. Each Logi-cal Point Group shall contain up to 15 physical points and shall be capable of initiating a sequence of control actions.
   c. Event-initiated control, signaling and/or annunciation sequences. One hundred percent of all connected devices shall be capable of being operated simultaneously.
   d. Priority display of multiple alarms.
   e. Complete supervision of all connected devices with no degraded operation.
   f. Complete reset capabilities at FACP and FACT.
2. Standby batteries capable of operating the FACP, FACT (except those supported by non-interruptible power supply systems), FAAP, FVEP, smoke detectors and alarm horns, strobes, secondary PC terminals, video display units and printers, shall be provided to automatically back up the emergency power source. The system shall have the capacity to operate FACP, as required per NFPA PCs for two hours, and then operate the fire alarm indicating devices for at least 15 minutes, per NFPA requirements. When commercial power is restored, the system shall transfer automatically to primary power. System power supply shall be equipped with battery charging circuits sufficient to recharge fully depleted batteries to within 70 percent of their maximum capacity within 12 hours.
3. System operating software and data file shall be resident in nonvolatile memory. Loss of power, momentary or for a sustained period shall not require reloading of the software.
4. All plug-in circuit boards shall be electrically supervised to assure that the proper board is in the proper position. Systems that use electrical continuity to supervise the presence of plug-in boards, but that do not assure that board positions have not been exchanged, shall provide additional means for the specified supervision, beyond that provided by locking covers.
5. The FACT shall be provided with battery backup or individual dedicated UPS.

I. Color code and minimum wire sizes for the fire alarm system as follows:
1. All wire is solid copper:
2. All insulation colors shall be continuous for the full length of the wire.

3. Wire Jackets shall be stamped with the "Circuit Type" designation or shall have an affixed label designating the "Circuit Type" every twenty lineal feet at a minimum.

Circuit Type	Colors		Size
	Wire	# Of Conductors	
Initiating Circuits	(+) Red (-) Black	2	18 (THHN)
Signaling Circuits	(+) Red (-) Black	2	16 Twisted
Speaker Circuits	(+) Orange (-) Brown	2	14 Twisted
Strobe Circuits	(+) Yellow (-) Blue	2	14 Twisted
Fire Fighter Phone Circuit	(+) Red (-) White	2	14 Twisted/ Shielded
Fire Fighter Phone Riser Circuit	(+) Red (-) White	2	14 Twisted/ Shielded
RS-485 Circuit	(+) Blue (-) Gray	2	16 Twisted
Damper Control	(+) Red (-) Black	2	14 THHN
AHU Shutdown Circuit	(+) Red (-) Black	2	14 THHN
24VDC Power Circuit	(+) White (-) Black	2	14 THHN
Fire Alarm Remote Light Circuit	(+) Red (-) Black	2	18 THHN
Speaker Phone Cut Out Circuit	(+) Orange (-) Brown	2	14 Twisted
Low Level Audio Riser Circuit	(+) Red (-) Black	2	14 Twisted/ Shielded
High Level Audio Riser Circuit	(+) Red (-) Black	2	14 Twisted
Door Holder Circuit	(+) Red (-) Black	2	14 Twisted

J. Intelligent Features:
   1. The following additional features shall be provided:
      a. The fire alarm detector cleaning shall be annunciated at the FACP as a trouble condition by the device.
      b. Dual Alarm threshold for day or night settings.

K. Interface With Other Systems:
   1. Interface design of fire alarm system with closed circuit television (CCTV) system and FO signal transmission system.
   2. The Electronic Security Department (ESD) will provide software to interface with the CCTV and fire alarm systems. CCTV and fire alarm manufacturers shall provide software protocol, for their systems, to ESD.
   3. Consultant may purchase copy of specifications for interfacing systems from the university for the purpose of determining interfacing requirements.
   4. Interface voice notification with the campus RAV system.

1.3 SUBMITTAL

A. Provide shop drawings as follows:
1. Floor plans with device layout, address and wiring.
2. FACP layout.
3. Riser diagrams.
4. Battery calculation.
5. Sequence of operation
6. Equipment cut sheets
7. FAAP layout.

B. CADD generated layouts for FACT screen graphics.

C. Operating and Maintenance Manuals.

D. Project Record Documents:
1. Prior to submittal of the as-built documents, submit a complete package of shop drawings to the university Facilities Operations Fire and Safety office for review. Drawings shall include floor plans and graphic maps for each building and/or floors.
2. Submit record documents in accordance with the requirements of Section 01 78 39 and the following:
   a. As-built point-to-point wiring diagrams depicting every device, including correct university room numbers.
   b. Revised schematic, wiring, and interconnection diagrams of all circuits, internal and external, for all equipment installed and exact locations for all devices. These schematics shall include the conductor color-coding and terminal number identification system, location of all terminal boxes complete with numbering and each device address.
   c. Complete, as-installed, riser diagrams indicating the wiring sequence of all alarm initiating devices, supervisory devices, and all signaling appliances on all signaling circuits.
   d. A complete description of the system operation, including a schedule of relay abbreviations used on the drawings, list of relay functions, and the sequence of relay operation during supervisory trouble and alarm conditions.
   e. Complete wiring and control diagrams for control and shutdown circuits for fan systems.

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in Intelligent Fire Management Systems.

B. Installer: Company with certified personnel specializing in smoke detection and fire alarm systems with five years' documented experience as a fire alarm installing contractor.

C. Fire Management system installer shall keep all smoke heads in the building covered until final building turn over. Failure to comply will mandate a complete cleaning of the individual heads on the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Edwards System Technology (Sole Sourced)

2.2 APPROVED INSTALLERS

A. ADT, Rockies Life Safety Division, 6510 Franklin Street, Denver, CO 80229, (720) 826-5923

B. Convergint – 7330 S. Alton Way, Suite 12K, Centennial, CO (303) 932-0757

C. Fire Alarm Services, Inc – 4800 West 60th Avenue, Arvada, CO 80003 (303) 466-8800

D. Meridian Fire and Security – 7173 S. Havana St Ste 400 Centennial CO, 80112 (303) 790-2520

E. Other Edward System Technology installers will be considered if they have successfully completed 3 similar projects (in size and complexity) in the past 5 years in the Denver Metro area and NICET certified. Installer must demonstrate ability to provide ongoing service to any system it installs. Other installers must be approved in writing by the University Project Manager prior to bidding on the project. University approval takes 5 business days.

2.3 MATERIALS, GENERAL

A. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. All equipment shall be listed and labeled by Underwriters Laboratories.

D. All sensors shall be of the intelligent type and shall mount on a common base. This base shall be incompatible with conventional detectors.

E. Where equipment of different manufacturers is used, such equipment shall be included under the required over-all UL system listing as a component of the integrated fire alarm system.

F. The system shall be designed to operate with unshielded wire, to the maximum practicable extent. Shielded wire may be used. FO cable shall be utilized, as required or as indicated by the design documents.

G. FACPs shall be provided with tamper switches on cabinet doors to protect against unauthorized access to internal devices. The panel shall provide commandable outputs, which can operate relays or logic level devices.

H. Memory data shall be contained in EEPROM non-volatile memory. If non-volatile battery-backed RAM provides memory, removal of the board shall not cause loss of memory contents. I. The Fire Alarm annunciator panels shall be LCD types.

J. Site Specific Customizing Software:
1. General:
a. Provide software and Programs with technical support and training for the university's Facilities Operations staff during installation of system and completion.
b. Alarm display shall include, as a minimum:

1) Indication of alarm condition, i.e. ABNORMAL OFF, HI ALARM/ LO ALARM, analog value or status, and English group and point identification such as "SMOKE DETECTOR BUILDING “A” - 2ND FLOOR- ROOM202".
2) A discrete per point alarm action taking message, such as "CALL MAINTENANCE DEPT. EXT 5561", of up to 480 characters.

c. System shall automatically transmit alarm and troubles to selectable university pagers via a commercial carrier such as "AT&T Wireless".

d. The network routing properties for a panel's common controls determine which panels will respond when an operator presses the corresponding control command switch (Reset, Alarm Silence, Panel/Trouble Silence, Drill, Alternate Sensitivity) on the 3-LCD module.

Only the panels defined in the selected network routing group will respond to the command. Any building connected by a bridge or other structure shall annunciate to its opposite number(s) alarm, supervisory, and trouble conditions via single LEDs on its front panel.

2. Point summary reports:
   a. Point summary reports shall include the current value/status and condition.
   b. Trend reports shall allow the operator to randomly select logical arrays of points.
   c. Dynamic trends shall provide up to six points and show real time activity of the associated points.
   d. Alarm reports shall be automatically issued.
   e. A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only.

K. Fire Alarm System Devices:
   1. General:
      a. Each device shall be assigned a unique address, 8 digit only Example (01020001). Address selection by jumpers is not acceptable. Devices which take their address from their position in the circuit are unacceptable. It is preferred that the address of the intelligent device be part of the device base rather than the device itself.
      b. Devices shall receive power and communication from the same pair of wires. For fault-tolerant circuits, any separate power wiring shall also be made fault-tolerant.
   2. Analog Sensors (Photoelectric and Thermal):
      a. Each sensor shall contain an LED, which blinks each time it is scanned by the FACP. The sensor LED is to remain illuminated to indicate alarm. All sensors not visible from the corridor shall have a remote light mounted in the corridor as shown on the drawings.
      b. Each sensor shall be capable of being tested for alarm via command from the FACP or FACT. The values of the sensor shall be displayed at building FACP and FACT, and the University Police FACT.
   3. Monitor Modules:
      a. The Monitor Module shall provide an addressable input for N.O. or N.C. contact devices such as manual stations, water-flow switches, sprinkler supervisory devices, door contacts, intrusion detectors, etc.
      b. The Module shall mount in a standard electrical box.
   4. Control Modules:
      a. The Control Module shall provide an addressable output for a separately powered alarm-indicating circuit or for a control relay.
      b. The relay contacts shall be SPST (Form "C" rated at 2 amps at 28V DC).
      c. The module shall mount in a standard electrical box.
      d. Control voltage’s connected to intelligent control relays shall not exceed 24VAC/24VDC. Isolation relays shall be used on control voltages on excess of 24VAC/24VDC.
   5. Fault Isolator Module (only if approved by the University Project Manager):
      a. The Fault Isolator Module shall detect and isolate a short-circuited segment of a fire-alarm loop.
      b. Modules shall be placed on every floor to limit the number lost addressable devices in case of a short-circuit on the intelligent circuit.

6. Intelligent manual pull stations shall be double action is typical on campus, mounted on standard electrical box. a. For public places, use single action pull stations with "Stopper II" cover.
7. Magnetic door holders shall be wall- or floor-mount on a standard electrical box.
8. Linear beam smoke detectors shall have cross-zone capabilities and be provided where shown on the drawings. Detectors shall consist of a transmitter and receiver unit utilizing infrared light to detect smoke between the units. These detectors shall have discriminating circuitry to differentiate between actual smoke, momentary blockage of the beam, and long-term blockage.
    a. Contractor shall provide a weatherproof enclosure for each pair of devices, utilizing transparent panels to allow light transmission. Ensure range of detector is adequate to compensate for passage through this glass.

L. Other Devices:
1. Speaker/Strobes:
    a. Strobes shall be synchronized.
    b. The speaker shall provide for minimum sound level of 95 dBA at 10 feet.
2. Analog Air Duct Detectors:
    a. Duct detectors shall be mounted exterior of duct with air sampling tube. Program duct detectors for supervisory indication only.
    b. Provide fire alarm remote light red LED, mounted on a standard plate fitted to a standard electrical box. When device is not visible, labeled plate with the name of the device served.
    c. Fire alarm remote light/test switch combination shall be utilized for each duct detector. The device shall have a red LED and two positions test switch mounted on a standard plate fitted to a standard electrical box. Plates shall be labeled with the name of the equipment served.
3. Tamper Switches: Installed under Division 21.
4. Flow Switches: Installed under Division 21.
5. Sprinkler Pre-action Solenoid and Deluge Valves: Installed under Division 21
6. Differential Pressure Switch: Installed under Division 23.
7. Damper End Switches: for damper position indication. Installed, under Division 23.
8. Relays provide addressable control and/or monitor module for each device indicated in paragraphs P. 3, 4, 5, 6 And 7 above. Include wiring to the device and to the fire alarm loop as required.
9. Provide control relays as required to accomplish functions such as fan shutdown, damper positioning, door release, etc.
10. Fire/Smoke dampers and smoke dampers will be provided under Division 23. The 24V wiring, including low voltage transformer P.E. switch, will be provided under Division 23. The 120V AC wiring will be provided under this section..
11. Voice Evacuation Speaker/Strobe units shall be UL listed for use in voice evacuation systems. Audible and visual indications shall operate independently or in unison.
12. Animal Care Facilities
    a. Provide “Silentone” horns or approved equal throughout all animal care facilities. Provide red lensed strobe in animal holding rooms.
    b. Provide speakers in the office areas of the animal facility.

M. Voice Evacuation System:
1. The Contractor shall provide all work required for installation of a Voice Evacuation System for the buildings indicated by the drawings. Scope of this Contractor's work will be as described by this section of the specifications and as shown on the drawings.
2. Buildings that are defined as high rise shall have the following: An Audible Alarm on the floor where that event is detected and a general message to all other floors stating, “ A fire Alarm has been detected on (indicate floor number). Remain alert and evacuate if there are indications of fire.

O. Voice Evacuation System:
1. The Contractor shall provide all work required for installation of a Voice Evacuation System for the buildings indicated by the drawings. Scope of this Contractor's work will be as described by

this section of the specifications and as shown on the drawings.

2. Buildings that are defined as high rise shall have the following: An Audible Alarm on the floor where that event is detected and a general message to all other floors stating, " A fire Alarm has been detected on (indicate floor number). Remain alert and evacuate if there are indications of fire. If no danger is noted, you may await further instruction. Elevators have been recalled to level 1(or alternate floor if the fire alarm is on level 1) until the fire alarm is over."
3. Fire Alarm Voice Evacuation Panel (FVEP):
   a. The FVEP shall be located in conjunction with the FACP and shall provide evacuation signals, pre-recorded fire alarm messages, and one-way communication (paging) on a selective.
   b. FVEP equipment shall include the following:
      1) Voice paging, hand-held, push-to-talk microphone with dynamic noise canceling.
         Frequency response shall be flat within + 3 dB from 200 to 5,000 Hz.
      2) Zone paging selector switches and LED's, with one selector switch and two LED's provided for each speaker zone.
      3) "Manual Fire Evacuation Tone" switch and LED.
      4) "Silencing" fire evacuation tones (self-restoring switch) and LED.
      5) "Pre-recorded Message" switch and LED.
      6) "All Call", switch and LED, with the switch enabling the operator to simultaneously page all speaker zones on both risers.
      7) Reset switch.
      8) Lamp test switch.
      9) "Page" LED, which will light when the paging microphone is used.
      10) The FVEP shall also be equipped with LED's to indicate trouble conditions for the following:
         a) Each individual speaker zone.
         b) Amplifier, preamplifier, fire tone, pre-recorded messages, and voices paging.
      11) All switches and LED's shall be clearly identified with engraved labels.
      12) Each group of LED's shall have distinctive colors, such as:
         a) Fire Tone -
         Red b) Silence -
         Yellow c) Page -
         Green
         d) Trouble - Yellow
         e) Pre-recorded Message - Red
   c. The fire evacuation signal shall be applied to any specific zone automatically from the FACP or FACT, or shall be selected manually by the speaker zone switch.

4. FVEP Audio Cabinet:
   a. 100% redundant tone generators, preamplifiers, and amplifiers shall be provided.
   b. The audio trunk shall be electronically supervised and shall be automatic switchover from one audio signal path to the other.
   c. Each amplifier module shall be provided with two 40-watt amplifiers, and shall power a minimum of 8 speaker zones.
   d. Pre-recorded message shall be programmed and recorded in a memory chip. Tape cassette players are not acceptable.
   e. The FVEP audio cabinet shall be capable of remote "All Page" activation via local microphone from the University Police Station. The system shall allow the selection of individual building or "All" buildings for "Disaster Messages".
   f. Provide capability of testing and adjusting audio amplifier outputs. Provide test switch at the FACP.

P. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.

PART 3 - EXECUTION

3.1 INSTALLATION – FIRE ALARM

A. Fire Alarm layouts:
1. General:
a. Provide a fire alarm system for each building.
1) Actual detection required per building shall be determined by National codes, Local codes and the university CBO, whichever is more stringent.
b. Provide shunt trip circuit breaker for connection to elevators with sprinkle red shafts.

2. Regardless of building occupancy rating, the following areas shall be provided with detection:
a. Laboratories
b. Electrical Rooms
c. Mechanical Rooms
d. Telecommunications Rooms
e. Data Centers
f. Dedicated Storage Rooms
g. Kitchens

3. In general, the following type of detection shall be provided in each type of room:
a. Photoelectric Smoke Detection:
1) Electrical/TelecommunicationRooms
2) Office Corridors (except where sprinkled)
3) Offices (except where sprinkled)
4) Laboratories
5) Mechanical Ducts
6) Elevator Shafts/Machine Rooms
7) Dedicated Storage Rooms
8) Linear Equipment Rooms
b. Thermal Detection:
1) Restrooms
2) Mechanical Rooms
3) Kitchens/Break rooms
4) Environmental Services (Janitor) Rooms
5) Elevator Shafts/Machine Rooms
6) Generator Rooms
7) Autoclaves
c. Flame Detection:
1) Generator Rooms
4. Provide control module at each access control panel for interface with access control system.

B. Installation shall be supervised and tested by the manufacturer of the system equipment.

C. Low Voltage/Wire and Cable: All LV/W&C shall be run in conduit in floors, walls and non accessible spaces. In hallways, LVW/C can be run in bridle rings attached to the common telecom and other low voltage system cable tray. LV/W&C must be run in a conduit sleeve, minimum 2” dia. with plastic bushings, from the point it leaves the bridle ring on the cable tray to the interior side of a room. Once the LV/W&C enters the room it can be supported from bridle rings or j-hooks. Wiring shall comply with Division 27 and approved NEC.

D. Low Voltage/Wire and Cable and Hallway Devices: LV/W&C running from the cable tray to devices in the hallway shall be protected by plenum rated flexible sleeving or flexible metal conduit. LV/W&C in

sleeving or flexible metal conduit shall be supported per NEC and installed with UL approved connectors and plastic bushings on both ends.

E. Outlet pull and junction boxes shall be painted red on the exterior. F. Devices: Locate devices per ADA standards.

G. In construction areas where there is existing equipment, the equipment must be protected during construction and the devices taken off line to eliminate false alarms. All devices associated with modifications to an existing.

H. Contractor is liable for damage. The university must be notified at the completion of each project to ensure that the system is returned to normal.

I. If room numbers are changed or new room numbers established, the University Project Manager must be notified before implementation so that the system can be re-programmed and is accurate in the event of an alarm.

J. All devices mounted in ceiling tile to be supported by T-bar hanger bracket and appropriate box. Plaster ring is not acceptable.

K. Labeling:
1. Observe the university fire alarm color code guide.
2. Label each splice with correct information.
3. Label each initiating device with correct device address. Use Kroy labeler or equal.
4. Final, correct university room numbers (not design/construction room numbers) must be provided for correct programming.
5. All detectors to have factory dust covers installed until after the final inspection and clean up is complete.
6. All duct detectors to have individual remote LED/test stations installed. Mount at 6'-0" AFF in main corridor adjacent to area served. Label as directed by the University Project Manager.
7. All shielded wiring to be bonded together at each device and insulated from contact with the conduit or box.
8. All equipment and associated wiring removed from service will be returned to the University Project Manager for proper disposal.
9. Avoid locating detectors above countertops and/or shelving.
10. Locate detectors at least eight feet from supply or return air diffusers.
11. Use fixed heat detectors near autoclaves and steam sterilizers.
12. Mount remote lights for room detectors above door to corridor, centered.

L. Construction Requirements:
1. Integrity of Structure: Do not drill or pierce structural members without prior approval from the University Project Manager and Structural Engineer.
2. Penetration of Walls, Etc.: Fire caulks or seal all penetrations made through walls, floors, and ceilings around the conduit. Maintain the integrity of fire ratings within the structure. Where visible, paint to match surface.
3. Wherever possible, install conduits and raceways in a concealed manner, except at surface-mounted cabinets.
4. Access to Existing Facilities: Install all conduit and pull boxes to maintain or provide access to existing valves; covers to existing pull boxes; wire ways or access doors; electrical outlets; switches; motors, etc.
5. Support bridle rings/"J" Hooks independently from structure, may have separate point of attachment to cable tray.
6. No other wiring or systems to be installed with fire alarm.
7. The addition or removal of any walls, doors, or other floor plan modifications will require the contractor to update the FACT graphics and graphic map at the FACP.

M. Prior to start of construction, disable existing fire alarm devices, as necessary. A minimum of two working days notice, prior to construction, shall be coordinated through the University Project Manager.

3.2 TESTING, CLEANING AND CERTIFICATION

A. When installation is complete, system shall be tested in accordance with NFPA72 requirements. A representative of the system manufacturer shall submit a written report of the findings to the A/E with copy of to the FD. System testing shall include, at the least, verifying the following:
1. The functional operation of each re-settable initiating device (manual stations, detectors, etc.) and circuit.
2. All notification appliances shall be tested for a minimum of ten minutes under normal alarm conditions.

H. Contractor is liable for damage. The university must be notified at the completion of each project to ensure that the system is returned to normal.

I. If room numbers are changed or new room numbers established, the University Project Manager must be notified before implementation so that the system can be re-programmed and is accurate in the event of an alarm.

J. All devices mounted in ceiling tile to be supported by T-bar hanger bracket and appropriate box. Plaster ring is not acceptable.

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8. All equipment and associated wiring removed from service will be returned to the University Project Manager for proper disposal.
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A. When installation is complete, system shall be tested in accordance with NFPA72 requirements. A representative of the system manufacturer shall submit a written report of the findings to the A/E with copy of to the FD. System testing shall include, at the least, verifying the following:
1. The functional operation of each re-settable initiating device (manual stations, detectors, etc.) and circuit.
2. All notification appliances shall be tested for a minimum of ten minutes under normal alarm conditions.
3. The functional operation of each and every alarm device and circuit.
4. The functional operation of each monitored device circuit.
5. The functional operation of each control circuit, including fan controls.
6. The supervision functions of each initiating, indicating, monitoring, control and supply circuit.
7. Control station automatic signaling.
8. That all software protocol, access codes and operation instructions have been supplied.
9. All installed or modified fire alarm systems for remodels or new projects shall be tested and certified by a Factory Representative. Upon a system test completion a "Letter of Certification" shall be issued to the university.

B. All testing and verifications shall be conducted in the presence of the university Facilities Operations Fire and Safety personnel.

C. There shall be an operational test by the FD.

3.4 COMMISSIONING (DEMONSTRATION)

A. The equipment supplier shall provide a minimum of 8 hours of system training for the university Facilities Operations personnel training for each new system.

PART 4 – CHANGE LOG

3/8/2021	1. Updated pre-approved distributor/installer list, added FAS.
	2. Added 3.1 L 7 – FACT and graphic map update requirements.
	3. Corrected various section numbering.
12/29/2020	1. Updated approved installer Systems Group and added ADT.

END OF SECTION 28 31 00