PROJECT MANUAL FOR:
WOMEN’S AND CHILDREN’S HOSPITAL - REPLACE AHU 4 & 11

PROJECT NUMBER:
CP190691

AT
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:
IMEG Corporation
15 Sunnen Dr., Suite 104
Maplewood MO, 63143
Contact: Tony Zehnle
Email: Tony.D.Zehnle@imegcorp.com
(314) 645-1132
(314) 645-1173 (fax)

DATE: December 19, 2019

ISSUED FOR BID
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PREPARED BY:
IMEG Corporation
15 Sunnen Dr., Suite 104
Maplewood MO, 63143
Contact: Robert Eshelman
Phone: (314) 390 6396
Fax: (314) 645-1173

CORE 10 Architecture
4501 Lindell Blvd., Suite 1A
Saint Louis MO, 63108
(314) 726-4858
(314)

DATE: December 19, 2019

I hereby certify that these Drawings and/or Specifications have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature:
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23 34 23  Power Ventilators
23 36 00  Air Terminal Units
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26 27 26  Wiring Devices
26 28 13  Fuses
26 28 16  Disconnect Switches
26 29 23  Variable Frequency Drives
28 31 00  Fire Alarm and Detection Systems

END OF SECTION
ADVERTISEMENT FOR BIDS

Sealed bids for:

WOMEN'S AND CHILDREN'S HOSPITAL –
REPLACE AHU 4 AND 11
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
PROJECT NUMBER: CP190691 CONSTRUCTION ESTIMATE $955,000 - $1,062,000

will be received by the Curators of the University of Missouri, Owner, at Campus Facilities, Planning, Design & Construction, Room L100 (Front Reception Desk), General Services Building, University of Missouri, Columbia, Missouri 65211, until 1:30 p.m., C.T., January 21, 2020 and then immediately opened and publicly read aloud.

Drawings, specifications, and other related contract information may be obtained at http://operations-webapps.missouri.edu/pdc/adsite/ad.html. Electronic bid sets are available at no cost and may be printed as desired by the plan holders. No paper copies will be issued. If paper copies are desired, it is the responsibility of the user to print the files or have them printed.

Questions regarding the scope of work should be directed to Robert Eshelman with IMEG at (314) 390-6396 or robert.e.eshelman@imegcorp.com. Questions regarding commercial conditions should be directed to Brad Rackers at (573) 884-7086 or rackersba@missouri.edu.

A prebid meeting will be held at 1:30, C.T., January 7, 2020 in the General Services Bldg., Rm 194B, University of Missouri, Columbia, Missouri, followed by a walk-through at the site. All interested bidders are invited to attend this meeting. A walk-through of the project may be scheduled by contacting the Prebid Inspection Guide at (573) 882-2228 or mucfpmprebidinspectionsguides@missouri.edu. A 24 – 48 hour advance notice is required for all walk-through request.

Information regarding bid results will be available the day following the bid opening by calling (573) 882-1133

A Diversity Participation goal of 10% MBE / 10% Combined WBE, DBE and Veteran Owned Business and 3% SDVE has been established for this contract.

The Owner reserves the right to waive informalities in bids and to reject any and all bids.

Individuals with special needs as addressed by the Americans with Disabilities Act may contact (573) 882-1133.

Advertisement Date: December 19, 2019

Gary L. Ward
Vice Chancellor for Operations and Chief Operating Officer
University of Missouri
SECTION 1.A

BID FOR LUMP SUM CONTRACT

Date:__________________

BID OF
(hereinafter called "Bidder") a corporation* organized and existing under laws of the State of ____________________________
a partnership* consisting of ____________________________
an individual* trading as ____________________________
a joint venture* consisting of ____________________________

*Insert Corporation(s), partnership or individual, as applicable.

TO: Curators of the University of Missouri
316 University Hall
Columbia, Missouri 65211

1. Bidder, in compliance with invitation for bids for construction work in accordance with Drawings and Specifications prepared by IMEG Corporation, entitled "WOMEN’S AND CHILDREN’S HOSPITAL - REPLACE AHU 4 & 11", project number CP190691, dated December 19, 2019 having examined Contract Documents and site of proposed work, and being familiar with all conditions pertaining to construction of proposed project, including availability of materials and labor, hereby proposes to furnish all labor, materials and supplies to construct project in accordance with Contract Documents, within time set forth herein at prices stated below. Prices shall cover all expenses, including taxes not covered by the University of Missouri’s tax exemption status, incurred in performing work required under Contract documents, of which this Bid is a part.

Bidder acknowledges receipt of following addenda:

Addendum No. ____________________________ Dated ____________
Addendum No. ____________________________ Dated ____________
Addendum No. ____________________________ Dated ____________
Addendum No. ____________________________ Dated ____________

2. In following Bid(s), amount(s) shall be written in both words and figures. In case of discrepancy between words and figures, words shall govern.

3. BID PRICING

a. Base Bid:
The Bidder agrees to furnish all labor, materials, tools, and equipment required to remove and replace two air handling units. One unit, AHU-4, serves the kitchen and will also require the removal and replacement of all lined ductwork attached to AHU-4. The kitchen will shutdown for a maximum of ten (10) days for all work to be completed within the kitchen. As a part of two add/alternates, the ceiling in the kitchen will be replaced with a lay-in ceiling. The other unit AHU-11 serves the emergency department and the sleep study area. This unit will need a temporary unit to be installed while the current unit is replaced. A piece of elevator equipment located within the mechanical room for AHU-11 will need to be enclosed by fire rated walls and doors to meet code. Twelve (12) terminal air boxes serving the sleep study and the emergency department will need to be upgraded from pneumatic controls; all as indicated on the Drawings and described in these Specifications for sum of:

______________________________ DOLLARS ($__________________________).

1.A - 1
b. Additive Alternate Bids:

Above Base Bid may be changed in accordance with following Alternate Bids as Owner may elect. Alternates are as described in Section 1.H of Project Manual. Alternates are written in a priority order, but Owner is not required to accept or reject in order listed. This is a one (1) contract project, therefore, Alternates shall be studied by each Bidder to determine effect on Bids of Contractor and each Subcontractor and/or Material supplier.

(1) **Additive Alternate No. 1:** Replacement of the kitchen ceiling within area A with a lay-in ceiling. This area will be considered any hard ceiling north of the exhaust hood. This will also include new light fixtures, diffusers and sprinkler heads. The total downtime that the kitchen can experience will be 21 days if this alternate is considered. All for sum of:

DOLLARS ($ )

(2) **Additive Alternate No. 2:** Replacement of the hard ceiling within area B of the kitchen with a lay-in ceiling. This will also include new light fixtures, diffusers and sprinkler heads. This add/alternate will be in addition to alternate 1. All for sum of:

DOLLARS ($ )

c. Unit Prices:

(1) For changing specified quantities of work from those indicated by Contract Drawings and Specifications, upon written instructions of Owner, the following Unit Prices shall prevail in accordance with General Conditions.

(2) The following Unit Prices include all labor, overhead and profit, materials, equipment, appliances, bailing, shoring, shoring removal, etc., to cover all work.

(3) The following Unit Prices are required where applicable to particular Base Bid and/or Alternate being submitted.

(4) Only a single Unit Price shall be given and it shall apply for either MORE or LESS work than that indicated on Drawings and called for in Specifications as indicated to be included in Base Bid and/or Alternates. In the event that more or less units than so indicated is actually furnished, Change Orders will be issued for increased or decreased amounts as approved by the Owner.

(5) Bidder understands that the Owner will not be liable for any Unit Price or any amount in excess of Base Bid and any Alternate(s) accepted at time of award of Contract, except as expressed in written Change Orders duly executed and delivered by Owner's Representative.

d. Allowance:

Bidder shall include in the base bid sum an allowance of $10,000 for patching and repairing of the structural steel above the kitchen. This allowance amount shall not include contractor's overhead and profit. The Contractor shall include overhead and profit on the allowance amount in his bid.

4. PROJECT COMPLETION

a. Contract Period - Contract period begins on the day the Contractor receives unsigned Contract, Performance Bond, Payment Bond, and "Instructions for Execution of Contract, Bonds, and
Insurance Certificates.” Bidder agrees to complete project within Three Hundred and Thirty Five (335) calendar days from receipt of aforementioned documents. Fifteen (15) calendar days have been allocated in construction schedule for receiving aforementioned documents from Bidder.

b. Commencement - Contractor agrees to commence work on this project after the "Notice to Proceed" is issued by the Owner. "Notice to Proceed" will be issued within seven (7) calendar days after Owner receives properly prepared and executed Contract documents listed in paragraph 4.a. above.

c. Liquidated Damages for the installation of AHU-4 - In event that Contractor shall fail to substantially complete the work as defined in Contract Documents within time fixed for such completion set forth in Contract Documents, Contractor shall pay to Owner as damages for each calendar day of delay in completing work, sum of 900 ($900) dollars per day. In view of difficulty of accurately ascertaining loss that Owner will suffer by reason of delay in completion of work, said sum is hereby fixed and agreed as liquidated damages that Owner will suffer by reason of such delay and not as penalty.

d. Refer to Special Scheduling Requirements in Special Conditions for specific scheduling of the following activities:
   1. Special work times
   2. Crane work
   3. HVAC Testing and Balancing
   4. Utility Shut-downs, Outages and Tie-ins
   5. Refuse / Trash Removal and Materials Delivery

5. **SUBCONTRACTOR LIST:**

Bidder hereby certifies that the following subcontractors will be used in performance of Work:

NOTE: Failure to list subcontractors for each category of work identified on this form or listing more than one subcontractor for any category of work without designating the portion of work performed by each shall be grounds for rejection of bid. List name, city, and state of designated subcontractor, for each category of work listed in Bid For Lump Sum Contract. If work within a category will be performed by more than one subcontractor, Bidder shall provide name, city, and state of each subcontractor and specify exact portion of work to be performed by each. If acceptance/non-acceptance of Alternates will affect designation of a subcontractor, Bidder shall provide information, for each affected category, with this bid form. If Bidder intends to perform any designated subcontract work by using Bidder's own employees, then Bidder shall list their own name, city, and state. The bidder may petition the Owner to change a listed subcontractor only within 48 hours of the bid opening. See Information For Bidders Section 16 List of Subcontractors for requirements.

<table>
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<tr>
<th>Work To Be Performed</th>
<th>Subcontractor Name, City and State</th>
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<td>FM/UL Certified Fire Stopping Contractor</td>
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<tr>
<td>Mechanical Contractor</td>
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<tr>
<td>Electrical Contractor</td>
<td></td>
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<tr>
<td>Fire Protection Contractor</td>
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<tr>
<td>Structural Steel Contractor</td>
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</tbody>
</table>

6. **SUPPLIER DIVERSITY GOALS**

a. The Contractor shall have as a goal subcontracting with Minority Business Enterprise (MBE) of 10% and Women Business Enterprise (WBE), Disadvantage Business Enterprise (DBE), Service Disabled Veteran Owned Business and/or Veteran Owned Business of 3% of awarded contract price for work to be performed.
b. Requests for waiver of this goal shall be submitted on the attached Application For Waiver form. A determination by the Director of Facilities Planning & Development, UM, that a good faith effort has not been made by Contractor to achieve above stated goal may result in rejection of bid.

c. The Undersigned proposes to perform work with following MBE/WBE participation level:

MBE PERCENTAGE PARTICIPATION: ________ percent (____ %)
WBE, DBE, SERVICE-DISABLED VETERAN, and/or VETERAN PERCENTAGE PARTICIPATION: ________ percent (____ %)

d. A Supplier Diversity Compliance Evaluation form shall be submitted with this bid for each diverse subcontractor to be used on this project.

7. BIDDER'S ACKNOWLEDGMENTS

a. Bidder declares that he has had an opportunity to examine the site of the work and he has examined Contract Documents therefore; that he has carefully prepared his bid upon the basis thereof; that he has carefully examined and checked bid, materials, equipment and labor required thereunder, cost thereof, and his figures therefore. Bidder hereby states that amount, or amounts, set forth in bid is, or are, correct and that no mistake or error has occurred in bid or in Bidder's computations upon which this bid is based. Bidder agrees that he will make no claim for reformation, modifications, revisions or correction of bid after scheduled closing time for receipt of bids.

b. Bidder agrees that bid shall not be withdrawn for a period of Ninety (90) days after scheduled closing time for receipt of bids.

c. Bidder understands that Owner reserves right to reject any or all bids and to waive any informalities in bidding.

d. Accompanying the bid is a bid bond, or a certified check, or an irrevocable letter of credit, or a cashier's check payable without condition to "The Curators of the University of Missouri" which is an amount at least equal to five percent (5%) of amount of largest possible total bid herein submitted, including consideration of Alternates.

e. Accompanying the bid is a Bidder's Statement of Qualifications. Failure of Bidder to submit the Bidder's Statement of Qualifications with the bid may cause the bid to be rejected. Owner does not maintain Bidder's Statements of Qualifications on file.

f. It is understood and agreed that bid security of two (2) lowest and responsive Bidders will be retained until Contract has been executed and an acceptable Performance Bond and Payment Bond has been furnished. It is understood and agreed that if the bid is accepted and the undersigned fails to execute the Contract and furnish acceptable Performance/Payment Bond as required by Contract Documents, accompanying bid security will be realized upon or retained by Owner. Otherwise, the bid security will be returned to the undersigned.

8. BIDDER'S CERTIFICATE

Bidder hereby certifies:

a. His bid is genuine and is not made in interest of or on behalf of any undisclosed person, firm or corporation, and is not submitted in conformity with any agreement or rules of any group, association or corporation.
b. He has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid.

c. He has not solicited or induced any person, firm or corporation to refrain from bidding.

d. He has not sought by collusion or otherwise to obtain for himself any advantage over any other Bidder or over Owner.

e. He will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin in connection with performance of work.

f. By virtue of policy of the Board of Curators, and by virtue of statutory authority, a preference will be given to materials, products, supplies, provisions and all other articles produced, manufactured, mined or grown within the State of Missouri. By virtue of policy of the Board of Curators, preference will also be given to all Missouri firms, corporations, or individuals, all as more fully set forth in "Information For Bidders."
9. **BIDDER'S SIGNATURE**

Note: All signatures shall be original; not copies, photocopies, stamped, etc.

<table>
<thead>
<tr>
<th>Authorized Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed Name</td>
<td>Title</td>
</tr>
<tr>
<td>Company Name</td>
<td></td>
</tr>
<tr>
<td>Mailing Address</td>
<td></td>
</tr>
<tr>
<td>City, State, Zip</td>
<td></td>
</tr>
<tr>
<td>Phone No.</td>
<td>Federal Employer ID No.</td>
</tr>
<tr>
<td>Fax No.</td>
<td>E-Mail Address</td>
</tr>
</tbody>
</table>

Circle one: Individual  Partnership  Corporation  Joint Venture

If a corporation, incorporated under the laws of the State of__________

Licensed to do business in the State of Missouri?  ____yes  ____no

(Each Bidder shall complete bid form by manually signing on the proper signature line above and supplying required information called for in connection with the signature. Information is necessary for proper preparation of the Contract, Performance Bond and Payment Bond. Each Bidder shall supply information called for in accompanying "Bidder's Statement of Qualifications.")

**END OF SECTION**
UNIVERSITY OF MISSOURI
BIDDER'S STATEMENT OF QUALIFICATIONS

Submit with Bid for Lump Sum Contract in separate envelope appropriately labeled. Attach additional sheet if necessary.

1. Company Name___________________________________________________________

   Phone# ___________________________ Fax #: ________________________________

   Address ______________________________________________________________

2. Number of years in business ______. If not under present firm name, list previous firm names and types of organization.

   ____________________________________________________________

3. List contracts on hand (complete the following schedule, include telephone number).

<table>
<thead>
<tr>
<th>Project &amp; Address</th>
<th>Owner/Owner's Representative</th>
<th>Phone Number</th>
<th>Architect</th>
<th>Amount of your Contract</th>
<th>Percent Completed</th>
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4. General character of work performed by your company personnel.

   ____________________________________________________________

5. List important projects completed in the last five (5) years on a type similar to the work now bid for, including approximate cost and telephone number.

<table>
<thead>
<tr>
<th>Project &amp; Address</th>
<th>Owner/Owner's Representative</th>
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</tbody>
</table>

6. Other experience qualifying you for the work now bid.

   ____________________________________________________________

7. No default has been made in any contract complete or incomplete except as noted below:

   (a) Number of contracts on which default was made _______________________

   (b) Description of defaulted contracts and reason therefor

   ____________________________________________________________

8. (a) Have you or your company participated in any contract subject to an equal opportunity clause similar to that described in the General Conditions?

   Yes _______ No ________

   (b) Have you filed all required compliance reports?

   Yes _______ No ________
(c) Is fifty percent or more of your company owned by a minority?
   Yes   No

(d) Is fifty percent or more of your company owned by a woman?
   Yes   No

(e) Is fifty percent or more of your company owned by a service disabled veteran?
   Yes   No

(f) Is fifty percent or more of your company owned by a veteran?
   Yes   No

(g) Is your company a Disadvantaged Business Enterprise?
   Yes   No

9. Have you or your company been suspended or debarred from working at any University of Missouri campus?
   Yes   No   (If the answer is "yes", give details.)

10. Have any administrative or legal proceedings been started against you or your company alleging violation of any wage and hour regulations or laws?
    Yes   No   (If the answer is "yes", give details.)

11. Workers Compensation Experience Modification Rates (last 3 yrs): / / 
    Incidence Rates (last 3 years):   /   /

12. List banking references.

13. (a) Do you have a current confidential financial statement on file with Owner?
    Yes   No   (If not, and if desired, Bidder may submit such statement with bid, in a separate sealed and labeled envelope.)

(b) If not, upon request will you file a detailed confidential financial statement within three (3) days?
    Yes   No

Dated at __________________________ this ______ day of __________________ 20____

_________________________________________________________________________

Name of Organization

_________________________________________________________________________

Signature

_________________________________________________________________________

Printed Name

_________________________________________________________________________

Title of Person Signing

END OF SECTION
SUPPLIER DIVERSITY COMPLIANCE EVALUATION FORM

This form shall be completed by Bidders and submitted with the Bidder's Statement of Qualifications form for each diverse firm who will function as a subcontractor on the contract.

The undersigned submits the following data with respect to this firm's assurance to meet the goal for Supplier Diversity participation.

<table>
<thead>
<tr>
<th>I. Project:</th>
</tr>
</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th>II. Name of General Contractor:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>III. Name of Diverse Firm:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

Address: ____________________________

Phone No.: ____________________________ Fax No.: ____________________________

Status (check one) MBE _____ WBE _____ Veteran_____ Service Disabled Veteran_____ DBE______

<table>
<thead>
<tr>
<th>IV. Describe the subcontract work to be performed. (List Base Bid work and any Alternate work separately):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Bid:</td>
</tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>V. Dollar amount of contract to be subcontracted to the Diverse firm:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Bid:</td>
</tr>
<tr>
<td>Alternate(s), (Identify separately):</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>VI. Is the proposed subcontractor listed in the Directory of M/W/DBE Vendors, Directory of Serviced Disabled Veterans and/or the Directory of Veterans maintained by the State of Missouri?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes _______ No _______</td>
</tr>
</tbody>
</table>

SD/1
Is the proposed subcontractor certified as a diverse supplier by any of the following: federal government agencies, state agencies, State of Missouri city or county government agencies, Minority and/or WBE certifying agencies?

Yes ______ No ______ If yes, please provide details and attach a copy of the certification.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Does the proposed subcontractor have a signed document from their attorney certifying the Supplier as a Diverse and meeting the 51% owned and committed requirement?

Yes ______ No ______ If yes, please attach letter.

________________________________________________________________________

Signature: ________________________________________________________________

Name: ____________________________________________________________________

Title: ___________________________________________________________________

Date: ___________________________________________________________________
APPLICATION FOR WAIVER

This form shall be completed and submitted with the Bidder's Statement of Qualifications. Firms wishing to be considered for award are required to demonstrate that a good faith effort has been made to include diverse suppliers. This form will be used to evaluate the extent to which a good faith effort has been made. The undersigned submits the following data with respect to the firm's efforts to meet the goal for Supplier Diversity Participation.

1. List pre-bid conferences your firm attended where Supplier Diversity requirements were discussed.

2. Identify advertising efforts undertaken by your firm which were intended to recruit potential diverse subcontractors for various aspects of this project. Provide names of newspapers, dates of advertisements and copies of ads that were run.

3. Note specific efforts to contact in writing those diverse suppliers capable of and likely to participate as subcontractors for this project.

4. Describe steps taken by your firm to divide work into areas in which diverse suppliers/contractors would be capable of performing.

5. What efforts were taken to negotiate with prospective diverse suppliers/contractors for specific sub-bids? Include the names, addresses, and telephone numbers of diverse suppliers/contractors contacted, a description of the information given to diverse suppliers/contractors regarding plans and specifications for the assigned work, and a statement as to why additional agreements were not made with diverse suppliers/contractors.

6. List reasons for rejecting a diverse supplier/contractor which has been contacted.
8. Describe the follow-up contacts with diverse suppliers/contractors made by your firm after the initial solicitation.

__________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________

9. Describe the efforts made by your firm to provide interested diverse suppliers/contractors with sufficiently detailed information about the plans, specifications and requirements of the contract.

__________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________

10. Describe your firm's efforts to locate diverse suppliers/contractors.

__________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________

Based on the above stated good faith efforts made to include supplier diversity, the bidder hereby requests that the original supplier diversity percentage goal be waived and that the percentage goal for this project be set at ________ percent.

The undersigned hereby certifies, having read the answers contained in the foregoing Application for Waiver, that they are true and correct to the best of his/her knowledge, information and belief.

Signature

Name

Title

Company

Date
AFFIDAVIT

“The undersigned swears that the foregoing statements are true and correct and include all material information necessary to identify and explain the operation of ____________________________ (name of firm) as well as the ownership thereof. Further, the undersigned agrees to provide through the prime contractor or directly to the Contracting Officer current, complete and accurate information regarding actual work performed on the project, the payment therefore and any proposed changes, if any, of the project, the foregoing arrangements and to permit the audit and examination of books, records and files of the named firm. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initiating action under federal or state laws concerning false statements.”

Note - If, after filing this information and before the work of this firm is completed on the contract covered by this regulation, there is any significant change in the information submitted, you must inform the Director of Facilities Planning and Development of the change either through the prime contractor or directly.

Signature ____________________________
Name ____________________________
Title ____________________________
Date ____________________________

Corporate Seal (where appropriate)

Date ____________________________
State of ____________________________
County of ____________________________

On this _______________________________________ day of _________________________________________, 19__, before me appeared (name) __________________________________________________ to me personally known, who, being duly sworn, did execute the foregoing affidavit, and did state that he or she was properly authorized by (name of firm) ____________________________ to execute the affidavit and did so as his or her own free act and deed.

(Seal)

Notary Public ____________________________
Commission expires ____________________________

SD/5
AFFIDAVIT FOR AFFIRMATIVE ACTION

State of Missouri  )
County of  ) ss.

______________________________________________________________________ first being duly sworn on his/her oath states: that he/she is the (sole proprietor, partner, or officer) of __________________________________________________ ______________________ a (sole proprietorship, partnership, corporation), and as such (sole proprietor, partner, or officer) is duly authorized to make this affidavit on behalf of said (sole proprietorship, partnership, corporation); that under the contract known as " " Project No. ________________ less than 50 persons in the aggregate will be employed and therefore, the applicable Affirmative Action requirements as set forth in the "Nondiscrimination in Employment Equal Opportunity," Supplemental Special Conditions, and Article 13 in the General Conditions do not apply.

______________________________________________________________________

Subscribed and sworn before me this _______________ day of ___________________________, 19________.

My commission expires ___________________________________________________________, 19________.
CERTIFYING SUPPLIER DIVERSITY AGENCIES

Diverse firms are defined in General Conditions Articles 1.1.7 and those businesses must be certified as disadvantaged by an approved agency. The Bidder is responsible for obtaining information regarding the certification status of a firm. A list of certified firms may be obtained by contacting the agencies listed below. Any firm listed as disadvantaged by any of the following agencies will be classified as a diverse firm by the Owner.

St. Louis Development Corporation
1520 Market St., Ste. 2000
St. Louis, MO 63103
P: 314.982.1400
W: www.stlouis-mo.gov/sldc/

Bi-State Development
211 N. Broadway, Ste. 700
St. Louis, MO 63102
P: 314.982.1400
W: www.metrostlouis.dbesystem.com

St. Louis Minority Business Council
211 N. Broadway, Ste. 1300
St. Louis, MO 63102
P: 314.231.5555
W: www.slmbc.org

U.S. Small Business Administration - St. Louis, MO
8(a) Contractors, Minority Small Business
1222 Spruce Street, Suite 10.103
St. Louis, MO 63101
P: 314.539.6600
W: www.sba.gov

Lambert St. Louis International Airport
Business Diversity Development Office
11495 Navaid
Bridgeton, MO 63044
P: 314-426-8111

City of Kansas City, Missouri
Human Relations Department, MBE/WBE Division
4th Floor, City Hall
414 E. 12th Street
Kansas City, MO 64106
P: 816.513.1836
W: kcmohrd.mwdbce.com/?TN=kcmohrd

Mid-States Minority Supplier Development Council
505 N. 7th Street, Ste. 1820
St. Louis, MO 63101
P: 314.278.5616
W: midstatesdc.org

U.S. Small Business Administration - Kansas City, MO
8(a) Contractors, Minority Small Business
1000 Walnut, Suite 500
Kansas City, MO 64106
P: 816.426.4900
W: kcmohrd.mwdbce.com/?TN=kcmohrd

Missouri Department of Transportation
Division of Construction
1617 Missouri Blvd.
P.O. Box 270
Jefferson City, MO 65102
P: 573.526.2978
W: www.modot.org/mrcc-directory

Illinois Department of Transportation
MBE/WBE Certification Section
2300 Dirksen Parkway
Springfield, IL 62764
217/782-5490; 217/785-1524 (Fax)
W: webapps.dot.illinois.gov/UCP/ExternalSearch

State of Missouri OA
Office of Equal Opportunity
301 W. High St. HSC Rm 870-B
Jefferson City, MO 65101
P: 877.259.2963
W: oa.mo.gov/sites/default/files/sdvelisting.pdf
W: oeo.mo.gov/
Minority Newspapers

Dos Mundos Bilingual Newspaper
902A Southwest Blvd.
Kansas City, MO 64108
816-221-4747
www.dosmundos.com

Kansas City Hispanic News
2918 Southwest Blvd.
Kansas City, MO 64108
816/472-5246
www.kchispanicnews.com

The Kansas City Globe
615 E. 29th Street
Kansas City, MO 64109
816-531-5253
www.thekcglobe.com/about_us.php

St. Louis American
4144 Lindell
St. Louis, MO 63108
314-533-8000
www.stlamerican.com

St. Louis Chinese American News
1766 Burns Ave, Suite 201
St. Louis, MO 63132
314-432-3858
www.scannews.com

St. Louis Business Journal
815 Olive St., Suite 100
St. Louis, MO 63101
314-421-6200
www.bizjournal.com/stlouis

Kansas City Business Journal
1100 Main Street, Suite 210
Kansas City, MO 64105
816-421-5900
www.bizjournals.com/kansascity
AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION

The apparent low Bidder shall complete and submit this form within 48 hours of bid opening for each Diverse firm that will participate on the contract.

1. Diverse Firm: ____________________________________________
   Contact Name: ____________________________________________
   Address: ________________________________________________
   Phone No.: ______________________________________________
   E-Mail: _________________________________________________

   Status (check one)  MBE ☐  WBE ☐  Veteran ☐  Service Disabled Veteran ☐  DBE ☐
   If MBE, Certified as (circle one): 1) Black American  2) Hispanic American  3) Native American  4) Asian American

2. Is the proposed diverse firm certified by an approved agency [see IFB article 15]?  Yes ☐  No ☐
   Agency: ___________________________ [attach copy of certification authorization from agency]
   Certification Number: ______________________________

3. Diverse firm scope work and bid/contract dollar amount of participation (List Base Bid and Alternate work separately). The final Dollar amount will be determined at substantial completion:

<table>
<thead>
<tr>
<th>Scope of Work</th>
<th>Bid/Contract Amount</th>
<th>Final Dollar Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Bid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternate #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternate #2</td>
<td></td>
<td></td>
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<tr>
<td>Alternate #3</td>
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<td>Alternate #4</td>
<td></td>
<td></td>
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<tr>
<td>Alternate #5</td>
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<td></td>
</tr>
<tr>
<td>Alternate #6</td>
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<td></td>
</tr>
</tbody>
</table>

The undersigned certifies that the information contained herein (i.e. Scope of Work and Bid/Contract Amount) is true and correct to the best of their knowledge, information and belief.

   General Contractor: ____________________________  Diverse Firm: ____________________________
   Signature: __________________________________________  Signature: ____________________________
   Name: _____________________________________________  Name: ___________________________________
   Title: _____________________________________________  Title: ___________________________________
   Date: _____________________________________________  Date: ___________________________________

The undersigned certifies that the information contained herein (i.e. Scope of Work and Final Dollar Amount) is true and correct to the best of their knowledge, information and belief. If the Final Dollar Amount is different than the Bid/Contract Amount, then attach justification for the difference.

   Contractor: ____________________________  Diverse Firm: ____________________________
   Signature: __________________________________________  Signature: ____________________________
   Name: _____________________________________________  Name: ___________________________________
   Title: _____________________________________________  Title: ___________________________________
   Date: _____________________________________________  Date: ___________________________________
**University of Missouri**

**INFORMATION FOR BIDDERS**

<table>
<thead>
<tr>
<th>Contract Documents</th>
<th>1. Drawings, specifications, and other contract documents, pursuant to work which is to be done, may be obtained shown in the Advertisement for Bids and Special Conditions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Bidder Obligations</td>
<td>2. Before submitting bids each bidder shall carefully examine the drawings and specifications and related contract documents, visit site of work and fully inform themselves as to all existing conditions, facilities, restrictions and other matters which can affect the work or the cost thereof.</td>
</tr>
<tr>
<td>3. Interpretation of Documents</td>
<td>3. Each bidder shall include in their bid the cost of all work and materials required to complete the contract in a first-class manner as hereinafter specified.</td>
</tr>
<tr>
<td>4. Bids</td>
<td>4. Failure or omission of any bidder to receive or examine any form, instrument, addendum, or other document, or to visit the site and acquaint themselves with existing conditions, shall in no way relieve them from any obligation with respect to their bid or contract, and no extra compensation will be allowed by reason of any thing or matter concerning which bidder should have fully informed themselves prior to bidding.</td>
</tr>
<tr>
<td>5. Modification and Withdrawal of Bids</td>
<td>5. Submission of bids shall be deemed acceptance of the above obligations and each and every obligation required to be performed by all of the contract documents in the event the bid is accepted.</td>
</tr>
<tr>
<td>6. Signing of Bids</td>
<td>6. If any prospective bidder is in doubt as to the true meaning of any part of the drawings and specifications or contract documents, they shall submit a written request to the Architect for an interpretation.</td>
</tr>
<tr>
<td>7. Bid Security</td>
<td>7. Requests for such interpretations shall be delivered to the Architect at least one (1) week prior to time for receipt of bids.</td>
</tr>
<tr>
<td>8. Bidder's Statement of Qualifications</td>
<td>8. Bids shall be based only on interpretations issued in the form of addenda mailed to each person who is on the Architect's record as having received a set of the contract documents.</td>
</tr>
<tr>
<td>9. Award of Contract</td>
<td>9. Bidders shall apportion each base bid between various phases of the work, as stipulated in the Bid for Lump Sum contract. All work shall be done as defined in the specifications and as indicated on the drawings.</td>
</tr>
<tr>
<td>10. Contract Execution</td>
<td>10. Bids shall be presented in sealed envelopes which shall be plainly marked &quot;Bids for (indicate name of project from cover sheet)&quot;, and mailed or delivered to the building and room number specified in the Advertisement for Bids. Bidders shall be responsible for actual delivery of bids during business hours, and it shall not be sufficient to show that a bid was mailed in time to be received before scheduled closing time for receipt of bids, nor shall it be sufficient to show that a bid was somewhere in a university facility.</td>
</tr>
<tr>
<td>11. Contract Security</td>
<td>11. The bidder's price shall include all federal sales, excise, and similar taxes, which may be lawfully assessed in connection with their performance of work and purchase of materials to be incorporated in the work. City &amp; State taxes shall not be included as defined within Article 3.16 of the General Conditions for Construction Contract included in the contract documents.</td>
</tr>
<tr>
<td>12. Time of Completion</td>
<td>12. Bids shall be submitted on a single bid form, furnished by the Owner or Architect. Do not remove the bid form from the specifications.</td>
</tr>
<tr>
<td>14. Missouri Products and Missouri Firms</td>
<td>14. Requests for such interpretations shall be delivered to the Architect at least one (1) week prior to time for receipt of bids.</td>
</tr>
<tr>
<td>15. Supplier Diversity</td>
<td>15. Bids shall be received separately or in combination as shown in and required by the Bid for Lump Sum contract. Bids will be completed so as to include insertion of amounts for alternate bids, unit prices and cost accounting data.</td>
</tr>
<tr>
<td>16. List of Subcontractors</td>
<td>16. Bidders shall be responsible for actual delivery of bids during business hours, and it shall not be sufficient to show that a bid was mailed in time to be received before scheduled closing time for receipt of bids, nor shall it be sufficient to show that a bid was somewhere in a university facility.</td>
</tr>
</tbody>
</table>

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**Page No.**

1. **Contract Documents**
2. **Bidder Obligations**
3. **Interpretation of Documents**
4. **Bids**
5. **Modification and Withdrawal of Bids**
6. **Signing of Bids**
7. **Bid Security**
8. **Bidder’s Statement of Qualifications**
9. **Award of Contract**
10. **Contract Execution**
11. **Contract Security**
12. **Time of Completion**
13. **Number of Contract Documents**
14. **Missouri Products and Missouri Firms**
15. **Supplier Diversity**
16. **List of Subcontractors**

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**University of Missouri**

**INFORMATION FOR BIDDERS**

<table>
<thead>
<tr>
<th>Page No.</th>
</tr>
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<tbody>
<tr>
<td>IFB/1</td>
</tr>
<tr>
<td>04/18</td>
</tr>
</tbody>
</table>
4.7 The Owner reserves the right to waive informalities in bids and to reject any or all bids.

5. Modification and Withdrawal of Bids

5.1 The bidder may withdraw their bid at any time before the scheduled closing time for receipt of bids, but no bidder may withdraw their bid after the scheduled closing time for receipt of bids.

5.2 Only telegrams, letters and other written requests for modifications or correction of previously submitted bids, contained in a sealed envelope which is plainly marked "Modification of Bid on [name of project on cover sheet]," which are addressed in the same manner as bids, and are received by Owner before the scheduled closing time for receipt of bids will be accepted and bids corrected in accordance with such written requests.

6. Signing of Bids

6.1 Bids which are signed for a partnership shall be manually signed in the firm name by at least one partner, or in the firm name by Attorney-in-Fact. If signed by Attorney-in-Fact there should be attached to the bid, a Power of Attorney evidencing authority to sign the bid dated the same date as the bid and executed by all partners of the firm.

6.2 Bids that are signed for a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation manually written below corporate name. Title of office held by the person signing for the corporation shall appear below the signature of the officer.

6.3 Bids that are signed by an individual doing business under a firm name, shall be manually signed in the name of the individual doing business under the proper firm name and style.

6.4 Bids that are signed under joint venture shall be manually signed by officers of the firms having authority to sign for their firm.

7. Bid Security

7.1 Each bid shall be accompanied by a bid bond, certified check, or cashier's check, acceptable to and payable without condition to The Curators of the University of Missouri, in an amount at least equal to five percent (5%) of bidder's bid including additive alternates.

7.2 Bid security is required as a guarantee that bidder will enter into a written contract and furnish a performance bond within the time and in form as specified in these specifications; and if successful bidder fails to do so, the bid security will be realized upon or retained by the Owner. The apparent low bidder shall notify the Owner in writing within 48 hours (2 work days) of the bid opening of any circumstance that may affect the bid security including, but not limited to, a bidding error. This notification will not guarantee release of the bidder’s security and/or the bidder from the Bidder’s Obligations.

7.3 If a bid bond is given as a bid security, the amount of the bond may be stated as an amount equal to at least five percent (5%) of the bid, including additive alternates, described in the bid. The bid bond shall be executed by the bidder and a responsible surety licensed in the State of Missouri with a Best’s rating of no less than A-/XI.

7.4 It is specifically understood that the bid security is a guarantee and shall not be considered as liquidated damages for failure of bidder to execute and deliver their contract and performance bond, nor limit or fix bidder’s liability to Owner for any damages sustained because of failure to execute and deliver the required contract and performance bond.

7.5 Bid security of the two (2) lowest and responsive Bidders will be retained by the Owner until a contract has been executed and an acceptable bond has been furnished, as required hereby, when such bid security will be returned. Surety bonds of all other bidders will be destroyed and all other alternative forms of bid bonds will be returned to them within ten (10) days after Owner has determined the two (2) lowest and responsive bids.

8. Bidder's Statement of Qualifications

8.1 Each bidder submitting a bid shall present evidence of their experience, qualifications, financial responsibility and ability to carry out the terms of the contract by completing and submitting with their bid the schedule of information set forth in the form furnished in the bid form.

8.2 Such information, a single copy required in a separate sealed envelope, will be treated as confidential information by the Owner, within the meaning of Missouri Statute 610.010.

8.3 Bids not accompanied with current Bidder's Statement of Qualifications may be rejected.

9. Award of Contract

9.1 The Owner reserves the right to let other contracts in connection with the work, including, but not by way of limitation, contracts for furnishing and installation of furniture, equipment, machines, appliances, and other apparatus.

9.2 In awarding the contract, the Owner may take into consideration the bidder's, and their subcontractor’s, ability to handle promptly the additional work, skill, facilities, capacity, experience, ability, responsibility, previous work, financial standing of bidder, and the bidder’s ability to provide the required bonds and insurance; quality, efficiency and construction of equipment proposed to be furnished; period of time within which equipment is proposed to be furnished and delivered; success in achieving the specified Supplier Diversity goal, or demonstrating a good faith effort as described in Article 15; necessity of prompt and efficient completion of work herein described, and the bidder’s status as suspended or debarred. Inability of any bidder to meet the requirements mentioned above may be cause for rejection of their bid.

10. Contract Execution

10.1 The Contractor shall submit within fifteen (15) days from receipt of notice, the documents required in Article 9 of the General Conditions for Construction Contract included in the contract documents.
10.2 No bids will be considered binding upon the Owner until the documents listed above have been furnished. Failure of Contractor to execute and submit these documents within the time period specified will be treated, at the option of the Owner, as a breach of the bidder's bid security under Article 7 and the Owner shall be under no further obligation to Bidder.

11. Contract Security

11.1 When the Contract sum exceeds $50,000, the Contractor shall procure and furnish a Performance bond and a Payment bond in the form prepared by Owner. Each bond shall be in the amount equal to one hundred percent (100%) of the contract sum, as well as adjustments to the Contract Sum. The Performance Bond shall secure and guarantee Contractor's faithful performance of this Contract, including but not limited to Contractor's obligation to correct defects after final payment has been made as required by the Contract Documents. The Payment Bond shall secure and guarantee payment of all persons performing labor on the Project under this Contract and furnishing materials in connection with this Contract. These Bonds shall be in effect through the duration of the Contract plus the Guaranty Period as required by the Contract Documents.

11.2 The bonds required hereunder shall be met all requirements of Article 11 of the General Conditions for Construction Contract included in the contract documents.

11.3 If the surety of any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to conduct business in the State of Missouri is terminated, or it ceases to meet the requirements of this Article 11, Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to Owner. If Contractor fails to make such substitution, Owner may procure such required bonds on behalf of Contractor at Contractor’s expense.

12. Time of Completion

12.1 Contractors shall agree to commence work within five (5) days of the date "Notice to Proceed" is received from the Owner, and the entire work shall be completed by the completion date specified or within the number of consecutive calendar days stated in the Special Conditions. The duration of the construction period, when specified in consecutive calendar days, shall begin when the contractor receives notice requesting the documents required in Article 9 of the General Conditions for Construction Contract included in the contract documents.

13. Number of Contract Documents

13.1 The Owner will furnish the Contractor a copy of the executed contract and performance bond.

13.2 The Owner will furnish the Contractor the number of copies of complete sets of drawings and specifications for the work, as well as, clarification and change order drawings pertaining to change orders required during construction as set forth in the Special Conditions.

14. Missouri Products and Missouri Firms

14.1 The Curators of the University of Missouri have adopted a policy which is binding upon all employees and departments of the University of Missouri, and which by contract, shall be binding upon independent contractors and subcontractors with the University of Missouri whereby all other things being equal, and when the same can be secured without additional cost over foreign products, or products of other states, a preference shall be granted in all construction, repair and purchase contracts, to all products, commodities, materials, supplies and articles mined, grown, produced and manufactured in marketable quantity and quality in the State of Missouri, to all firms, corporations or individuals doing business as Missouri firms, corporations or individuals. Each bidder submitting a bid agrees to comply with, and be bound by the foregoing policy.

15. Supplier Diversity

15.1 Award of Contract

The Supplier Diversity participation goal for this project is stated on the Bid for Lump Sum Contract Form, and the Owner will take into consideration the bidder's success in achieving the Supplier Diversity participation goal in awarding the contract. Inability of any bidder to meet this requirement may be cause for rejection of their bid.

The University will grant a three (3) point bonus preference to a Missouri based, certified Service Disabled Veteran Enterprise (SDVE) bidder as defined in Article 1 – (Supplier Diversity Definitions) of the General Conditions of the Contract for Construction included in the contract documents. The three percent (3%) goal can be met, and the bonus points obtained, by a qualified SDVE vendor and/or through the use of qualified subcontractors or suppliers that provide at least three percent (3%) of the total contract value.

15.2 List of Supplier Diversity Firms

15.2.1 The bidder shall submit as part of their bid a list of diverse firms performing as contractor, subcontractors, and/or suppliers. The list shall specify the single designated diverse firm name and address. If acceptance or non-acceptance of alternates will affect the designation of a subcontractor, provide information for each affected category.

15.2.2 Failure to include a complete list of diverse firms may be grounds for rejection of the bid.

15.2.3 The list of diverse firms shall be submitted in addition to any other listing of subcontractors required in the Bid for Lump Sum Contract Form.

15.3 Supplier Diversity Percentage Goal

The bidder shall have a minimum goal of subcontracting with diverse contractors, subcontractors, and suppliers, the percent of contract price stated in the Supplier Diversity goal paragraph of the Bid for Lump Sum Contract Form.

15.4 Supplier Diversity Percent Goal Computation

15.4.1 The total dollar value of the work granted to the diverse firms by the successful bidder is counted towards the applicable goal of the entire contract, unless otherwise noted below.

15.4.2 The bidder may count toward the Supplier Diversity goal only expenditures to diverse firms that perform a commercially useful function in the work of a contract. A diverse firm is considered to perform a commercially useful function when it is responsible for executing a distinct element of the work and carrying out its responsibilities by
For projects with separate MBE, SDVE, and WBE/Veteran as 100% of the contract towards the Supplier Diversity goal. A bidder that is a certified diverse firm may count expected to obtain the required SDVE, and WBE/Veteran/DBE goals, a MBE firm bidding as the prime bidder is actually performing, managing and supervising the work involved. The bidder may count toward its Supplier Diversity goal expenditures for materials and supplies obtained from diverse suppliers and manufacturers, provided the diverse firm assumes the actual and contractual responsibility for the provision of the materials and supplies.

15.4.4 The bidder may count toward its Supplier Diversity goal expenditures for materials and supplies obtained from diverse suppliers and manufacturers, provided the diverse supplier performs a commercially useful function as defined above in the supply process.

15.4.5 The bidder may count toward the Supplier Diversity goal that portion of the total dollar value of the work awarded to a certified joint venture equal to the percentage of the ownership and control of the diverse partner in the joint venture.

15.4.6 On projects with separate MBE and WBE/Veteran/DBE goals, the Owner may allow MBE participation provided in excess of the MBE goal to be counted towards the WBE/Veteran/DBE goal.

15.5 Certification by Bidder of Diverse Firms

15.5.1 The bidder shall submit with its bid the information requested in the "Supplier Diversity Compliance Evaluation Form" for every diverse firm the bidder intends to award work to on the contract.

15.5.2 Diverse firms are defined in Article 1 – (Supplier Diversity Definitions) of the General Conditions of the Contract for Construction included in the contract documents, and as those businesses certified as disadvantaged by an approved agency. The bidder is responsible for obtaining information regarding the certification status of a firm. A list of certified firms may be obtained by contacting the agencies listed in the proposal form document "Supplier Diversity Certifying Agencies". Any firm listed as disadvantaged by any of the identified agencies will be classified as a diverse firm by the Owner.

15.5.3 Bidders are urged to encourage their prospective diverse contractors, subcontractors, joint venture participants, team partners, and suppliers who are not currently certified to obtain certification from one of the approved agencies.

15.6 Supplier Diversity Participation Waiver

15.6.1 The bidder is required to make a good faith effort to locate and contract with diverse firms. If a bidder has made a good faith effort to secure the required diverse firms and has failed, the bidder shall submit with the bid, the information requested in "Application for Supplier Diversity Participation Waiver." The Contracting Officer will review the bidder's actions as set forth in the bidder's "Application for Waiver" and any other factors deemed relevant by the Contracting Officer to determine if a good faith effort has been made to meet the applicable percentage goal. If the bidder is judged not to have made a good faith effort, the bid may be rejected. Bidders who demonstrate that they have made a good faith effort to include Supplier Diversity participation may be awarded the contract regardless of the percent of Supplier Diversity participation, provided the bid is otherwise acceptable and is determined to be the best bid.

15.6.2 To determine good faith effort of the bidder, the Contracting Officer may evaluate factors including, but not limited to, the following:

15.6.2.1 The bidder’s attendance at pre-proposal meetings scheduled to inform bidders and diverse firms of contracting and subcontracting opportunities and responsibilities associated with Supplier Diversity participation.

15.6.2.2 The bidder’s advertisements in general circulation trade association, and diverse (minority) focused media concerning subcontracting opportunities.

15.6.2.3 The bidder’s written notice to specific diverse firms that their services were being solicited in sufficient time to allow for their effective participation.

15.6.2.4 The bidder’s follow-up attempts to the initial solicitation(s) to determine with certainty whether diverse firms were interested.

15.6.2.5 The bidder’s efforts to divide the work into packages suitable for subcontracting to diverse firms.

15.6.2.6 The bidder’s efforts to provide interested diverse firms with sufficiently detailed information about the drawings, specific actions and requirements of the contract, and clear scopes of work for the firms to bid on.
15.6.2.7 The bidder’s efforts to solicit for specific sub-bids from diverse firms in good faith. Documentation should include names, addresses, and telephone numbers of firms contacted a description of all information provided the diverse firms, and an explanation as to why agreements were not reached.

15.6.2.8 The bidder's efforts to locate diverse firms not on the directory list and assist diverse firms in becoming certified as such.

15.6.2.9 The bidder's initiatives to encourage and develop participation by diverse firms.

15.6.2.10 The bidder’s efforts to help diverse firms overcome legal or other barriers impeding the participation of diverse firms in the construction contract.

15.6.2.11 The availability of diverse firms and the adequacy of the bidder's efforts to increase the participation of such business provided by the persons and organizations consulted by the bidder.

15.7 Submittal of Forms
15.7.1 The bidder will include the Supplier Diversity Compliance Evaluation Form(s), or the Application for Waiver and other form(s) as required above in the envelope containing the "Bidder's Statement of Qualifications", see Article 8.

15.8 Additional Bid/Proposer Information
15.8.1 The Contracting Officer reserves the right to request additional information regarding Supplier Diversity participation and supporting documentation from the apparent low bidder. The bidder shall respond in writing to the Contracting Officer within 24 hours (1 work day) of a request.

15.8.2 The Contracting Officer reserves the right to request additional information after the bidder has responded to prior 24 hour requests. This information may include follow up and/or clarification of the information previously submitted.

15.8.3 The Owner reserves the right to consider additional diverse subcontractor and supplier participation submitted by the bidder after bids are opened under the provisions within these contract documents that describe the Owner’s right to accept or reject subcontractors including, but not limited to, Article 16 below. The Owner may elect to waive the good faith effort requirement if such additional participation achieves the Supplier Diversity goal.

15.8.4 The Bidder shall provide the Owner information related to the Supplier Diversity participation included in the bidder’s proposal, including, but is not limited to, the complete Application for Waiver, evidence of diverse certification of participating firms, dollar amount of participation of diverse firms, information supporting a good faith effort as described in Article 15.6 above, and a list of all diverse firms that submitted bids to the Bidder with the diverse firm’s price and the name and the price of the firm awarded the scope of work bid by the diverse firm.

16. List of Subcontractors
16.1 If a list of subcontractors is required on the Bid for Lump Sum Contract Form, the bidders shall list the name, city and state of the firm(s) which will accomplish that portion of the contract requested in the space provided. This list is separate from both the list of diverse firms required in Article 15.2, and the complete list of subcontractors required in Article 10.1 of this document. Should the bidder choose to perform any of the listed portions of the work with its own forces, the bidder shall enter its own name, city and state in the space provided. If acceptance or non-acceptance of alternates will affect the designation of a subcontractor, the bidder shall provide that information on the bid form.

16.2 Failure of the bidder to supply the list of subcontractors required or the listing of more than one subcontractor for any category without designating the portion of the work to be performed by each, shall be grounds for the rejection of the bid. The bidder can petition the Owner to change a listed subcontractor within 48 hours of the bid opening. The Owner reserves the right to make the final determination on a petition to change a subcontractor. The Owner will consider factors such as clerical and mathematical bidding errors, listed subcontractor’s inability to perform the work for the bid used, etc. Any request to change a listed subcontractor shall include at a minimum, contractor’s bid sheet showing tabulation of the bid; all subcontractor bids with documentation of the time they were received by the contractor; and a letter from the listed subcontractor on their letterhead stating why they cannot perform the work if applicable. The Owner reserves the right to ask for additional information.

16.3 Upon award of the contract, the requirements of Article 10 of this document and Article 5 of the General Conditions of the Contract for Construction included in the contract documents will apply.
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ARTICLE 1
GENERAL PROVISIONS

1.1 Basic Definitions
As used in the Contract Documents, the following terms shall have the meanings and refer to the parties designated in these definitions.

1.1.1 Owner
The Curators of the University of Missouri. The Owner may act through its Board of Curators or any duly authorized committee or representative thereof.

1.1.2 Contracting Officer
The Contracting Officer is the duly authorized representative of the Owner with the authority to execute contracts. Communications to the Contracting Officer shall be forwarded via the Owner's Representative.

1.1.3 Owner's Representative
The Owner’s Representative is authorized by the Owner as the administrator of the Contract and will represent the Owner during the progress of the Work. Communications from the Architect to the Contractor and from the Contractor to the Architect shall be through the Owner's Representative, unless otherwise indicated in the Contract Documents.

1.1.4 Architect
When the term "Architect" is used herein, it shall refer to the Architect or the Engineer specified and defined in the Contract for Construction or its duly authorized representative. Communications to the Architect shall be forwarded to the address shown in the Contract for Construction.

1.1.5 Contractor
The Contractor is the person or entity with whom the Owner has entered into the Contract for Construction. The term “Contractor” means the Contractor or the Contractor’s authorized representative.

1.1.6 Subcontractor and Lower-tier Subcontractor
A Subcontractor is a person or organization who has a contract with the Contractor to perform any of the Work. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or its authorized representative. The term "Subcontractor" also is applicable to those furnishing materials to be incorporated in the Work whether work performed is at the Owner’s site or off site, or both. A lower-tier Subcontractor is a person or organization who has a contract with a Subcontractor or another lower-tier Subcontractor to perform any of the Work at the site. Nothing contained in the Contract Documents shall create contractual relationships between the Owner or the Architect and any Subcontractor or lower-tier Subcontractor of any tier.

1.1.7 Supplier Diversity Definitions
Businesses that fall into the Supplier Diversity classification shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more diverse suppliers as described below.

1.1.7.1 Minority Business Enterprises (MBE)
Minority Business Enterprise [MBE] shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more minorities as defined below or, in the case of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more minorities as defined below, and whose management and daily business operations are controlled by one (1) or more minorities as defined herein.

.1.1.7.1.1 "African Americans", which includes persons having origins in any of the black racial groups of Africa.

.1.1.7.1.2 "Hispanic Americans", which includes persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.

.1.1.7.1.3 "Native Americans", which includes persons of American Indian, Eskimo, Aleut, or Native Hawaiian origin.

.1.1.7.1.4 "Asian-Pacific Americans", which includes persons whose origins are from Japan, China, Taiwan, Korea, Vietnam, Laos, Cambodia, the Philippines, Samoa, Guam, the U.S. Trust Territories of the Pacific, or the Northern Marinas.

.1.1.7.1.5 "Asian-Indian Americans", which includes persons whose origins are from India, Pakistan, or Bangladesh.

1.1.7.2 Women Business Enterprise (WBE)
Women Business Enterprise [WBE] shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more women or, in the case of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more women, and whose management and daily business operations are controlled by one (1) or more women.

1.1.7.3 Veteran Owned Business
Veteran Owned Business shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more Veterans or, in the case of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more Veterans, and whose management and daily business operations are controlled by one (1) or more Veterans. Veterans must be certified by the appropriate federal agency responsible for veterans’ affairs.

1.1.7.4 Service Disabled Veteran Enterprise (SDVE)
Service Disabled Veteran Enterprise (SDVE) shall mean a business certified by the State of Missouri Office of Administration as a Service Disabled Veteran Enterprise, which is at least fifty-one percent (51%) owned and controlled by one (1) or more Serviced Disabled Veterans or,
in the case of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more Service Disabled Veterans, and whose management and daily business operations are controlled by one (1) or more Serviced Disabled Veterans.

.5 Disadvantaged Business Enterprise (DBE)
A Disadvantaged Business Enterprise (DBE) is a for-profit small business concern where a socially and economically disadvantaged individual owns at least 51% interest and also controls management and daily business operations. These firms can and also be referred to as Small Disadvantaged Businesses (SDB). Eligibility requirements for certification are stated in 49 CFR (Code of Federal Regulations), part 26, Subpart D.

U.S. citizens that are African-Americans, Hispanics, Native Americans, Asian-Pacific and Subcontinent Asian Americans, and women are presumed to be socially and economically disadvantaged. Also recognized as DBE’s are Historically Black Colleges and Universities (HBCU) and small businesses located in Federal HUB Zones.

To be regarded as economically disadvantaged, an individual must have a personal net worth that does not exceed $1.32 million. To be seen as a small business, a firm must meet Small Business Administration (SBA) size criteria (500 employees or less) and have average annual gross receipts not to exceed $22.41 million. To be considered a DBE/SDB, a small business owned and controlled by socially and/or economically disadvantaged individuals must receive DBE certification from one of the recognized Missouri state agencies to be recognized in this classification.

1.1.9 Work
Work shall mean supervision, labor, equipment, tools, material, supplies, incidentals operations and activities required by the Contract Documents or reasonably inferable by Contractor therefrom as necessary to produce the results intended by the Contract Documents in a safe, expeditious, orderly, and workmanlike manner, and in the best manner known to each respective trade.

1.1.10 Approved
The terms "approved", "equal to", "directed", "required", "ordered", "designated", "acceptable", "satisfactory", and similar words or phrases will be understood to have reference to action on the part of the Architect and/or the Owner's Representative.

1.1.11 Contract Documents
The Contract Documents consist of (1) the executed Contract for Construction, (2) these General Conditions of the Contract for Construction, (3) any Supplemental Conditions or Special Conditions identified in the Contract for Construction, (4) the Specifications identified in the Contract for Construction, (5) the Drawings identified in the Contract for Construction, (6) Addenda issued prior to the receipt of bids, (7) Contractor's bid addressed to Owner, including Contractor's completed Qualification Statement, (8) Contractor's Performance Bond and Contractor's Payment Bond, (9) Notice to Proceed, (10) and any other exhibits and/or post bid adjustments identified in the Contract for Construction, (11) Advertisement for Bid, (12) Information for Bidders, and (13) Change Orders issued after execution of the Contract. All other documents and technical reports and information are not Contract Documents, including without limitation, Shop Drawings, and Submittals.

1.1.12 Contract
The Contract Documents form the Contract and are the exclusive statement of agreement between the parties. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior representations or agreements, either written or oral. The Contract Documents shall not be construed to create a contractual relationship of any kind between the Owner and a Subcontractor or any lower-tier Subcontractor.

1.1.13 Change Order
The Contract may be amended or modified without invalidating the Contract, only by a Change Order, subject to the limitations in Article 7 and elsewhere in the Contract Documents. A Change Order is a written instrument signed by the Owner and the Contractor stating their agreement to a change in the Work, the amount of the adjustment to the Contract Sum, if any, and the extent of the adjustment to the Contract Time, if any. Agreement to any Change Order shall constitute a final settlement of all matters relating to the change in the work which is the subject of the Change Order, including, but not limited to, all direct and indirect costs associated with such change and any and all adjustments of the Contract sum, time and schedule.

1.1.14 Substantial Completion
The terms “Substantial Completion” or "substantially complete" as used herein shall be construed to mean the completion of the entire Work, including all submittals required under the Contract Documents, except minor items which in the opinion of the Architect, and/or the Owner's Representative will not interfere with the complete and satisfactory use of the facilities for the purposes intended.

1.1.15 Final Completion
The date when all punch list items are completed, including all closeout submittals and approval by the Architect is given to the Owner in writing.

1.1.16 Supplemental and Special Conditions
The terms “Supplemental Conditions” or “Special Conditions” shall mean the part of the Contract Documents which amend, supplement, delete from, or add to these General Conditions.

1.1.17 Day
The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

1.1.18 Knowledge.
The terms “knowledge,” “recognize” and “discover,” their respective derivatives and similar terms in the Contract Documents, as used in reference to the Contractor, shall be interpreted to mean that which the Contractor knows or should know, recognizes or should recognize and discovers or should discover in exercising the care, skill, and diligence of a diligent and prudent contractor familiar with the work. Analogously, the expression “reasonably inferable” and similar terms in the Contract Documents shall be interpreted to mean reasonably inferable by a diligent and prudent contractor familiar with the work.

1.1.19 Punch List
“Punch List” means the list of items, prepared in connection with the inspection of the Project by the Owner's Representative or Architect in connection with Substantial Completion of the Work or a portion of the Work, which the Owner's Representative or Architect has designated as remaining to be performed, completed or corrected before the Work will be accepted by the Owner.

1.1.20 Public Works Contracting Minimum Wage
The public works contracting minimum wage shall be equal to one hundred twenty percent of the average hourly wage in a particular locality, as determined by the Missouri economic research and information center within the department of economic development, or any successor agency.

1.2 Specifications and Drawings
1.2.1 The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, construction system, standards and workmanship and performance of related services for the Work identified in the Contract for Construction. Specifications are separated into titled divisions for convenience of reference only. Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade. Such separation will not operate to make the Owner or the Architect an arbiter of labor disputes or work agreements.

1.2.2 The drawings herein referred to, consist of drawings prepared by the Architect and are enumerated in the Contract Documents.

1.2.3 Drawings are intended to show general arrangements, design, and dimensions of work and are partly diagrammatic. Dimensions shall not be determined by scale or rule. If figured dimensions are lacking, they shall be supplied by the Architect on the Contractor's written request to the Owner's Representative.

1.2.4 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complimentary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall by required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the intended results.

1.2.5 In the event of inconsistencies within or between parts of the Contract Documents, or between the Contract Documents and applicable standards, codes and ordinances, the Contractor shall (1) provide the better quality or greater quantity of Work or (2) comply with the more stringent requirement; either or both in accordance with the Owner’s Representative’s interpretation. On the Drawings, given dimensions shall take precedence over scaled measurements and large scale drawings over small scale drawings. Before ordering any materials or doing any Work, the Contractor and each Subcontractor shall verify measurements at the Work site and shall be responsible for the correctness of such measurements. Any difference which may be found shall be submitted to the Owner’s Representative and Architect for resolution before proceeding with the Work. If a minor change in the Work is found necessary due to actual field conditions, the Contractor shall submit detailed drawings of such change for the approval by the Owner’s Representative and Architect before making the change.

1.2.6 Data in the Contract Documents concerning lot size, ground elevations, present obstructions on or near the site, locations and depths of sewers, conduits, pipes, wires, etc., position of sidewalks, curbs, pavements, etc., and nature of ground and subsurface conditions have been obtained from sources the Architect believes reliable, but the Architect and Owner do not represent or warrant that this information is accurate or complete. The Contractor shall verify such data to the extent possible through normal construction procedures, including but not limited to contacting utility owners and by prospecting.

1.2.7 Only work included in the Contract Documents is authorized, and the Contractor shall do no work other than that described therein.
1.2.8 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become familiar with local conditions under which the Work is to be performed and correlated personal observations with requirements of the Contract Documents. Contractor represents that it has performed its own investigation and examination of the Work site and its surroundings and satisfied itself before entering into this Contract as to:

1.1 conditions bearing upon transportation, disposal, handling, and storage of materials;
1.2 the availability of labor, materials, equipment, water, electrical power, utilities and roads;
1.3 uncertainties of weather, river stages, flooding and similar characteristics of the site;
1.4 conditions bearing upon security and protection of material, equipment, and Work in progress;
1.5 the form and nature of the Work site, including the surface and sub-surface conditions;
1.6 the extent and nature of Work and materials necessary for the execution of the Work and the remedying of any defects therein; and
1.7 the means of access to the site and the accommodations it may require and, in general, shall be deemed to have obtained all information as to risks, contingencies and other circumstances.
1.8 the ability to complete work without disruption to normal campus activities, except as specifically allowed in the contract documents.

The Owner assumes no responsibility or liability for the physical condition or safety of the Work site or any improvements located on the Work site. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or Contract Time concerning any failure by the Contractor or any Subcontractor to comply with the requirements of this Paragraph.

1.2.9 Drawings, specifications, and copies thereof furnished by the Owner are and shall remain the Owner’s property. They are not to be used on another project and, with the exception of one contract set for each party to the Contract, shall be returned to the Owner's Representative on request, at the completion of the Work.

1.3 Required Provisions Deemed Inserted
Each and every provision of law and clause required by law to be inserted in this Contract shall be deemed to be inserted herein, and the Contract shall be read and enforced as though it were included herein; and if through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the written application of either party the Contract shall forthwith be physically amended to make such insertion or correction.

ARTICLE 2
OWNER

2.1 Information and Services Required of the Owner
2.1.1 Permits and fees are the responsibility of the Contractor under the Contract Documents, unless specifically stated in the contract documents that the Owner will secure and pay for specific necessary approvals, easements, assessments, and charges required for construction, use or occupancy of permanent structures, or for permanent changes in existing facilities.

2.1.2 When requested in writing by the Contractor, information or services under the Owner's control, which are reasonably necessary to perform the Work, will be furnished by the Owner with reasonable promptness to avoid delay in the orderly progress of the Work.

2.2 Owner's Right to Stop the Work
2.2.1 If the Contractor fails to correct Work which is not in strict accordance with the requirements of the Contract Documents or fails to carry out Work in strict accordance with the Contract Documents, the Owner's Representative may order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work will not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity. Owner’s lifting of Stop Work Order shall not prejudice Owner’s right to enforce any provision of this Contract.

2.3 Owner's Right to Carry Out the Work
2.3.1 If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents, and fails within a seven (7) day period after receipt of a written notice from the Owner to correct such default or neglect, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. In such case, an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the cost of correcting such deficiencies, including compensation for the Architect’s additional services and expenses made necessary by such default or neglect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to Owner. However, such notice shall be waived in the event of an emergency with the potential for property damage or the endangerment of students, faculty, staff, the public or construction personnel, at the sole discretion of the Owner.

2.3.2 In the event the Contractor has not satisfactorily completed all items on the Punch List within thirty (30) days of its receipt, the Owner reserves the right to complete the Punch List without further notice to the Contractor or its
surety. In such case, Owner shall be entitled to deduct from payments then or thereafter due the Contractor the cost of completing the Punch List items, including compensation for the Architect's additional services. If payments then or thereafter due Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to Owner.

2.4 Extent of Owner Rights
2.4.1 The rights stated in this Article 2 and elsewhere in the Contract Documents are cumulative and not in limitation of any rights of the Owner (1) granted in the Contract Documents, (2) at law or (3) in equity.

2.4.2 In no event shall the Owner have control over, charge of, or any responsibility for construction means, methods, techniques, sequences or procedures or for safety precautions and programs in connection with the Work, notwithstanding any of the rights and authority granted the Owner in the Contract Documents.

ARTICLE 3
CONTRACTOR

3.1 Contractor's Warranty
3.1.1 The Contractor warrants all equipment and materials furnished, and work performed, under this Contract, against defective materials and workmanship for a period of twelve months after acceptance as provided in this Contract, unless a longer period is specified, regardless of whether the same were furnished or performed by the Contractor or any Subcontractors of any tier. Upon written notice from the Owner of any breach of warranty during the applicable warranty period due to defective material or workmanship, the affected part or parts thereof shall be repaired or replaced by the Contractor at no cost to the Owner. Should the Contractor fail or refuse to make the necessary repairs, replacements, and tests when requested by the Owner, the Owner may perform, or cause the necessary work and tests to be performed, at the Contractor's expense, or exercise the Owner's rights under Article 14.

3.1.2 Should one or more defects mentioned above appear within the specified period, the Owner shall have the right to continue to use or operate the defective part or apparatus until the Contractor makes repairs or replacements or until such time as it can be taken out of service without loss or inconvenience to the Owner.

3.1.3 The above warranties are not intended as a limitation, but are in addition to all other express warranties set forth in this Contract and such other warranties as are implied by law, custom, and usage of trade. The Contractor, and its surety or sureties, if any, shall be liable for the satisfaction and full performance of the warranties set forth herein.

3.1.4 Neither the final payment nor any provision in the Contract Documents nor partial or entire occupancy of the premises by the Owner, nor expiration of warranty stated herein, will constitute an acceptance of Work not done in accordance with the Contract Documents or relieve the Contractor of liability in respect to any responsibility for non-conforming work. The Contractor shall immediately remedy any defects in the Work and pay for any damage to other Work resulting therefrom upon written notice from the Owner. Should the Contractor fail or refuse to remedy the non-conforming work, the Owner may perform, or cause to be performed the work necessary to bring the work into conformance with the Contract Documents at the Contractor's expense.

3.1.5 The Contractor agrees to defend, indemnify, and save harmless The Curators of the University of Missouri, their Officers, Agents, Employees and Volunteers, from and against all loss or expense from any injury or damages to property of others suffered or incurred on account of any breach of the aforesaid obligations and covenants. The Contractor agrees to investigate, handle, respond to and provide defense for and defend against any such liability, claims, and demands at the sole expense of the Contractor, or at the option of the University, agrees to pay to or reimburse the University for the defense costs incurred by the University in connection with any such liability claims, or demands. The parties hereto understand and agree that the University is relying on, and does not waive or intend to waive by any provision of this Contract, any monetary limitations or any other rights, immunities, and protections provided by the State of Missouri, as from time to time amended, or otherwise available to the University, or its officers, employees, agents or volunteers.

3.2 Compliance with Laws, Permits, Regulations and Inspections
3.2.1 The Contractor shall, without additional expense to the Owner, comply with all applicable laws, ordinances, rules, statutes, and regulations (collectively referred to as "Laws").

3.2.2 Since the Owner is an instrumentality of the State of Missouri, municipal, or political subdivision, ordinances, zoning ordinances, and other like ordinances are not applicable to construction on the Owner's property, and the Contractor will not be required to submit plans and specifications to any municipal or political subdivision authority to obtain construction permits or any other licenses or permits from or submit to, inspection by any municipality or political subdivision relating to the construction on the Owner's property, unless required by the Owner in these Contract Documents or otherwise in writing.

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3.2.3 All fees, permits, inspections, or licenses required by municipality or political subdivision for operation on property not belonging to the Owner, shall be obtained by and paid for by the Contractor. The Contractor, of its own expense, is responsible to ensure that all inspections required by said permits or licenses on property, easements, or utilities not belonging to the Owner are conducted as required therein. All connection charges, assessments or transportation fees as may be imposed by any utility company or others are included in the Contract Sum and shall be the Contractor’s responsibility, as stated in 2.1.1 above.

3.2.4 If the Contractor has knowledge that any Contract Documents are at variance with any Laws, including Americans with Disabilities Act – Standards for Accessible Design, ordinances, rules, regulations or codes applying to the Work, Contractor shall promptly notify the Architect and the Owner’s Representative, in writing, and any necessary changes will be adjusted as provided in Contract Documents. However, it is not the Contractor’s primary responsibility to ascertain that the Contract Documents are in accordance with applicable Laws, unless such Laws bear upon performance of the Work.

3.3 Anti-Kickback
3.3.1 No member or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this Contract or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this Contract if made with a corporation for its general benefit.

3.3.2 No official of the Owner who is authorized in such capacity and on behalf of the Owner to negotiate, make, accept or approve, or to take part in negotiating, making, accepting, or approving any architectural, engineering, inspection, construction, or material supply contract or any Subcontract of any tier in connection with the construction of the Work shall have a financial interest in this Contract or in any part thereof, any material supply contract, Subcontract of any tier, insurance contract, or any other contract pertaining to the Work.

3.4 Supervision and Construction Procedures
3.4.1 The Contractor shall supervise and direct the Work, using the Contractor’s best skill and attention. The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the Work under the Contract. The Contractor shall supply sufficient and competent supervision and personnel, and sufficient material, plant, and equipment to prosecute the Work with diligence to ensure completion thereof within the time specified in the Contract Documents, and shall pay when due any laborer, Subcontractor of any tier, or supplier.

3.4.2 The Contractor, if an individual, shall give the Work an adequate amount of personal supervision, and if a partnership or corporation or joint venture the Work shall be given an adequate amount of personal supervision by a partner or executive officer, as determined by the Owner's Representative.

3.4.3 The Contractor and each of its Subcontractors of any tier shall submit to the Owner such schedules of quantities and costs, progress schedules in accordance with 3.17.2 of this document, payrolls, reports, estimates, records, and other data as the Owner may request concerning Work performed or to be performed under the Contract.

3.4.4 The Contractor shall be represented at the site by a competent superintendent from the beginning of the Work until its final acceptance, whenever contract work is being performed, unless otherwise permitted in writing by the Owner's Representative. The superintendent for the Contractor shall exercise general supervision over the Work and such superintendent shall have decision making authority of the Contractor. Communications given to the superintendent shall be binding as if given to the Contractor. The superintendent shall not be changed by the contractor without approval from the Owner’s Representative.

3.4.5 The Contractor shall establish and maintain a permanent bench mark to which access may be had during progress of the Work, and Contractor shall establish all lines and levels, and shall be responsible for the correctness of such. Contractor shall be fully responsible for all layout work for the proper location of Work in strict accordance with the Contract Documents.

3.4.6 The Contractor shall establish and be responsible for wall and partition locations. If applicable, separate contractors shall be entitled to rely upon these locations and for setting their sleeves, openings, or chases.

3.4.7 The Contractor’s scheduled outage/tie-in plan, time, and date for any utilities is subject to approval by the Owner’s Representative. Communication with the appropriate entity and planning for any scheduled outage/tie-in of utilities shall be the responsibility of the Contractor. Failure of Contractor to comply with the provisions of this Paragraph shall cause Contractor to forfeit any right to an adjustment of the Contract Sum or Contract Time for any postponement, rescheduling or other delays ordered by Owner in connection with such Work. The Contractor shall follow the following procedures for all utility outages/tie-ins or disruption of any building system:

.1 All shutting of valves, switches, etc., shall be by the Owner's personnel.
.2 The Contractor shall submit its preliminary outage/tie-in schedule with its baseline schedule.
.3 The Contractor shall request an outage/tie-in meeting at least two weeks before the outage/tie-in is required.
.4 The Owner's Representative will schedule an outage/tie-in meeting at least one week prior to the outage/tie-in.

3.4.8 The Contractor shall coordinate all Work so there shall be no prolonged interruption of existing utilities, systems and equipment of Owner. Any existing plumbing, heating, ventilating, air conditioning, or electrical disconnection necessary, which affect portions of this construction or building or any other building, must be scheduled with the Owner's Representative to avoid any disruption of operation within the building under construction or other buildings or utilities. In no case shall utilities be left disconnected at the end of a work day or over a weekend. Any interruption of utilities, either intentionally or accidentally, shall not relieve the Contractor from repairing and restoring the utility to normal service. Repairs and restoration shall be made before the workers responsible for the repair and restoration leave the job.

3.4.9 The Contractor shall be responsible for repair of damage to property on or off the project occurring during construction of project, and all such repairs shall be made to meet code requirements or to the satisfaction of the Owner's Representative if code is not applicable.

3.4.10 The Contractor shall be responsible for all shoring required to protect its work or adjacent property and shall pay for any damage caused by failure to shore or by improper shoring or by failure to give proper notice. Shoring shall be removed only after completion of permanent supports.

3.4.11 The Contractor shall maintain at his own cost and expense, adequate, safe and sufficient walkways, platforms, scaffolds, ladders, hoists and all necessary, proper, and adequate equipment, apparatus, and appliances useful in carrying on the Work and which are necessary to make the place of Work safe and free from avoidable danger for students, faculty, staff, the public and construction personnel, and as may be required by safety provisions of applicable laws, ordinances, rules regulations and building and construction codes.

3.4.12 During the performance of the Work, the Contractor shall be responsible for providing and maintaining warning signs, lights, signal devices, barricades, guard rails, fences, and other devices appropriately located on site which shall give proper and understandable warning to all persons of danger of entry onto land, structure, or equipment, within the limits of the Contractor’s work area.

3.4.13 The Contractor shall pump, bail, or otherwise keep any general excavations free of water. The Contractor shall keep all areas free of water before, during and after concrete placement. The Contractor shall be responsible for protection, including weather protection, and proper maintenance of all equipment and materials installed, or to be installed by him.

3.4.14 The Contractor shall be responsible for care of the Work and must protect same from damage of defacement until acceptance by the Owner. All damaged or defaced Work shall be repaired or replaced to the Owner's satisfaction, without cost to the Owner.

3.4.15 When requested by the Owner's Representative, the Contractor, at no extra charge, shall provide scaffolds or ladders in place as may be required by the Architect or the Owner for examination of Work in progress or completed.

3.4.16 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor’s employees, Subcontractors of any tier and their agents and employees, and any entity or other persons performing portions of the Work.

3.4.17 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Owner’s Representative or Architect in their administration of the Contract, or by tests, inspections or approvals required or performed by persons other than the Contractor.

3.4.18 The Contractor shall be responsible for inspection of portions of the Work already performed under this Contract to determine that such portions are in proper condition to receive subsequent Work.

3.5 Use of Site
3.5.1 The Contractor shall limit operations and storage of material to the area within the Work limit lines shown on Drawings, except as necessary to connect to exiting utilities, shall not encroach on neighboring property, and shall exercise caution to prevent damage to existing structures.

3.5.2 Only materials and equipment, which are to be used directly in the Work, shall be brought to and stored on the Work site by the Contractor. After equipment is no longer required for the Work, it shall be promptly removed from the Work site. Protection of construction materials and equipment stored at the Work site from weather, theft, damage and all other adversity is solely the responsibility of the Contractor.
3.5.3 No project signs shall be erected without the written approval of the Owner's Representative.

3.5.4 The Contractor shall ensure that the Work is at all times performed in a manner that affords reasonable access, both vehicular and pedestrian, to the site of the Work and all adjacent areas. Particular attention shall be paid to access for emergency vehicles, including fire trucks. Wherever there is the possibility of interfering with normal emergency vehicle operations, Contractor shall obtain permission from both campus and municipal emergency response entities prior to limiting any access. The Work shall be performed, to the fullest extent reasonably possible, in such a manner that public areas adjacent to the site of the Work shall be free from all debris, building materials and equipment likely to cause hazardous conditions. Without limitation of any other provision of the Contract Documents, Contractor shall not interfere with the occupancy or beneficial use of (1) any areas and buildings adjacent to the site of the Work or (2) the Work in the event of partial occupancy. Contractor shall assume full responsibility for any damage to the property comprising the Work or to the owner or occupant of any adjacent land or areas resulting from the performance of the Work.

3.5.5 The Contractor shall not permit any workers to use any existing facilities at the Work site, including, without limitation, lavatories, toilets, entrances, and parking areas other than those designated by Owner. The Contractor, Subcontractors of any tier, suppliers and employees shall comply with instructions or regulations of the Owner's Representative governing access to, operation of, and conduct while in or on the premises and shall perform all Work required under the Contract Documents in such a manner as not to unreasonably interrupt or interfere with the conduct of Owner’s operations. Any request for Work, a suspension of Work or any other request or directive received by the Contractor from occupants of existing buildings shall be referred to the Owner’s Representative for determination.

3.5.6 The Contractor and the Subcontractor of any tier shall have its’ name, acceptable abbreviation or recognizable logo and the name of the city and state of the mailing address of the principal office of the company, on each motor vehicle and motorized self-propelled piece of equipment which is used in connection with the project. The signs are required on such vehicles during the time the Contractor is working on the project.

3.6 Review of Contract Documents and Field Conditions by Contractor

3.6.1 The Contractor shall carefully study and compare the Contract Documents with each other and with information furnished by the Architect and Owner and shall at once report in writing to the Architect and Owner’s Representative any errors, inconsistencies or omissions discovered. If the Contractor performs any construction activity which it knows or should have known involves a recognized error, inconsistency or omission in the Contract Documents without such written notice to the Architect and Owner’s Representative, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.

3.6.2 The Contractor shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Errors, inconsistencies or omissions discovered shall be reported in writing to the Architect and Owner’s Representative within twenty-four (24) hours. During the progress of work, Contractor shall verify all field measurements prior to fabrication of building components or equipment, and proceed with the fabrication to meet field conditions. Contractor shall consult all Contract Documents to determine the exact location of all work and verify spatial relationships of all work. Any question concerning said location or spatial relationships shall be submitted to the Owner's Representative. Specific locations for equipment, pipelines, ductwork and other such items of work, where not dimensioned on plans, shall be determined in consultation with Owner's Representative and Architect. Contractor shall be responsible for the proper fitting of the Work in place.

3.6.3 The Contractor shall provide, at the proper time, such material as required for support of the Work. If openings or chases are required, whether shown on Drawings or not, the Contractor shall see they are properly constructed. If required openings or chases are omitted, the Contractor shall cut them at the Contractors own expense, but only as directed by the Architect, through the Owner Representative.

3.6.4 Should the Contract Documents fail to particularly describe materials or goods to be used, it shall be the duty of the Contractor to inquire of the Architect and the Owner’s Representative what is to be used and to supply it at the Contractor’s expense, or else thereafter replace it to the Owner’s Representative’s satisfaction. At a minimum, the Contractor shall provide the quality of materials as generally specified throughout the Contract Documents.

3.7 Cleaning and Removal

3.7.1 The Contractor shall keep the Work site and surrounding areas free from accumulation of waste materials, rubbish, debris, and dirt resulting from the Work and shall
3.8 Cutting and Patching

3.8.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly.

3.8.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate contractor the Contractor's consent to cutting or otherwise altering the Work.

3.8.3 If the Work involves renovation and/or alteration of existing improvements, Contractor acknowledges that cutting and patching of the Work is essential for the Work to be successfully completed. Contractor shall perform any cutting, altering, patching, and/or fitting of the Work necessary for the Work and the existing improvements to be fully integrated and to present the visual appearance of an entire, completed, and unified project. In performing any Work which requires cutting or patching, Contractor shall use its best efforts to protect and preserve the visual appearance and aesthetics of the Work to the reasonable satisfaction of both the Owner’s Representative and Architect.

3.9 Indemnification

3.9.1 To the fullest extent permitted by law, the Contractor shall defend, indemnify, and hold harmless the Owner, the Architect, Architect’s consultants, and the agents, employees, representatives, insurers and re-insurers of any of the foregoing (hereafter collectively referred to as the “Indemnitees”) from and against claims, damages (including loss of use of the Work itself), punitive damages, penalties and civil fines unless expressly prohibited by law, losses and expenses, including, but not limited to, attorneys’ fees, arising out of or resulting from performance of the Work to the extent caused in whole or in part by negligent acts or omissions or other fault of Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by the negligent acts or omissions or other fault of a party indemnified hereunder. The Contractor’s obligations hereunder are in addition to and shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that the Owner may possess. If one or more of the Indemnitees demand performance by the Contractor of obligations under this paragraph or other provisions of the Contract Documents and if Contractor refuses to assume or perform, or delays in assuming or performing Contractor’s obligations, Contractor shall pay each Indemnitee who has made such demand its respective attorneys’ fees, costs, and other expenses incurred in enforcing this provision. The defense and indemnity required herein shall be a binding obligation upon Contractor whether or not an Indemnitee has made such demand. Even if a defense is successful to a claim or demand for which Contractor is obligated to indemnify the Indemnitees from under this Paragraph, Contractor shall remain liable for all costs of defense.

3.9.2 The indemnity obligations of Contractor under this Section 3.9 shall survive termination of this Contract or final payment thereunder. In the event of any claim or demand made against any party which is entitled to be indemnified hereunder, the Owner may in its sole discretion reserve, return or apply any monies due or to become due the Contractor under the Contract for the purpose of resolving such claims; provided, however, that the Owner may release such funds if the Contractor provides the Owner with reasonable assurance of protection of the Owner’s interests. The Owner shall in its sole discretion determine if such assurances are reasonable. Owner reserves the right to control the defense and settlement of any claim, action or proceeding which Contractor has an obligation to indemnify the Indemnitees against under Paragraph 3.9.1.

3.9.3 In claims against any person or entity indemnified under this Section 3.9 by an employee of the Contractor, a Subcontractor of any tier, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under this Section 3.9 shall not be limited by a limitation on amount or type of
3.9.4 The obligations of the Contractor under Paragraph 3.9.1 shall not extend to the liability of the Architect, his agents or employees, arising out of the preparation and approval of maps, drawings, opinions, reports, surveys, Change Orders, designs, or Specifications.

3.10 Patents
3.10.1 The Contractor shall hold and save harmless the Owner and its officers, agents, servants, and employees from liability of any nature or kind, including cost and expense, for, or on account of, any patented or otherwise protected invention, process, article, or appliance manufactured or used in the performance of the Contract, including its use by the Owner, unless otherwise specifically stipulated in the Contract Documents.

3.10.2 If the Contractor uses any design, device, or material covered by letters patent or copyright, he shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device, or material. It is mutually agreed and understood, without exception, that the Contract Sum includes and the Contractor shall pay all royalties, license fees or costs arising from the use of such design, device, or material in any way involved in the Work. The Contractor and/or sureties shall indemnify and save harmless the Owner from any and all claims for infringement by reason of the use of such patented or copyrighted design, device, or material or any trademark or copyright in connection with Work agreed to be performed under this Contract and shall indemnify the Owner for any cost, expense, or damage it may be obligated to pay by reason of such infringement at any time during the prosecution of the Work or after completion of the Work.

3.11 Materials, Labor, and Workmanship
3.11.1 Materials and equipment incorporated into the Work shall strictly conform to the Contract Documents and representations and approved Samples provided by Contractor and shall be of the most suitable grade of their respective kinds for their respective uses, and shall be fit and sufficient for the purpose intended, merchantable, of good new material and workmanship, and free from defect. Workmanship shall be in accordance with the highest standard in the industry and free from defect in strict accordance with the Contract Documents.

3.11.2 Materials and fixtures shall be new and of latest design unless otherwise specified, and shall provide the most efficient operating and maintenance costs to the Owner. All Work shall be performed by competent workers and shall be of best quality.

3.11.3 The Contractor shall carefully examine the Contract Documents and shall be responsible for the proper fitting of his material, equipment, and apparatus into the building.

3.11.4 The Contractor shall base his bid only on the Contract Documents.

3.11.5 Materials and workmanship shall be subject to inspection, examination, and test by the Architect and the Owner's Representative at any and all times during manufacture, installation, and construction of any of them, at places where such manufacture, installation, or construction is performed.

3.11.6 The Contractor shall enforce strict discipline and good order among the Contractor’s employees and other persons carrying out the Contract. The Contractor shall not permit employment of unfit persons or persons not skilled in tasks assigned to them.

3.11.7 Unless otherwise specifically noted, the Contractor shall provide and pay for supervision, labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for the proper execution and completion of the Work.

3.11.8 Substitutions
3.11.8.1 A substitution is a Contractor proposal of an alternate product or method in lieu of has been specified or shown in the Contract Documents, which is not an “or equal” as set forth in Section 3.12.1.

3.11.8.2 Contractor may make a proposal to the Architect and the Owner’s Representative to use substitute products or methods as set forth herein, but the Architect's and the Owner’s Representative’s decision concerning acceptance of a substitute shall be final. The Contractor must do so in writing and setting forth the following:

1. Full explanation of the proposed substitution and submittal of all supporting data including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures, and other like information necessary for a complete evaluation of the substitution.
2. Reasons the substitution is advantageous and necessary, including the benefits to the Owner and the Work in the event the substitution is acceptable.
3. The adjustment, if any, in the Contract Sum, in the event the substitution is acceptable.
4. The adjustment, if any, in the time of completion of the Contract and the construction schedule in the event the substitution is acceptable.
5. An affidavit stating that (a) the proposed substitution conforms to and meets all of the
Contract Documents, except as specifically disclosed and set forth in the affidavit and (b) the Contractor accepts the warranty and correction obligations in connection with the proposed substitution as if originally specified by the Architect. Proposals for substitutions shall be submitted to the Architect and Owner’s Representative in sufficient time to allow the Architect and Owner’s Representative no less than ten (10) working days for review. No substitution will be considered or allowed without the Contractor’s submittal of complete substantiating data and information as stated herein.

3.11.8.3 Substitutions may be rejected without explanation in Owner’s sole discretion and will be considered only under one or more of the following conditions:

1. Required for compliance with interpretation of code requirements or insurance regulations then existing;
2. Unavailability of specified products, through no fault of the Contractor;
3. Material delivered fails to comply with the Contract Documents;
4. Subsequent information discloses inability of specified products to perform properly or to fit in designated space;
5. Manufacturer/fabricator refuses to certify or guarantee performance of specified product as required; or
6. When in the judgment of the Owner or the Architect, a substitution would be substantially to the Owner’s best interests, in terms of cost, time, or other considerations.

3.11.8.4 Whether or not any proposed substitution is accepted by the Owner or the Architect, the Contractor shall reimburse the Owner for any fees charged by the Architect or other consultants for evaluating each proposed substitute.

3.12 Approved Equal

3.12.1 Whenever in the Contract Documents any article, appliance, device, or material is designated by the name of a manufacturer, vendor, or by any proprietary or trade name, the words "or approved equal," shall automatically follow and shall be implied unless specifically indicated otherwise. The standard products of manufacturers other than those specified will be accepted when, prior to the ordering or use thereof, it is proven to the satisfaction of the Owner’s Representative and the Architect they are equal in design, appearance, spare parts availability, strength, durability, usefulness, serviceability, operation cost, maintenance cost, and convenience for the purpose intended. Any general listings of approved manufacturers in any Contract Document shall be for informational purposes only and it shall be the Contractor’s sole responsibility to ensure that any proposed “or equal” complies with the requirements of the Contract Documents.

3.12.2 The Contractor shall submit to Architect and Owner’s Representative a written and full description of the proposed “or equal” including all supporting data, including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures, and similar information demonstrating that the proposed “or equal” strictly complies with the Contract Documents. The Architect or Owner’s Representative shall take appropriate action with respect to the submission of a proposed “or equal” item. If Contractor fails to submit proposed “or equals” as set forth herein, it shall waive any right to supply such items. The Contract Sum and Contract Time shall not be adjusted as a result of any failure by Contractor to submit proposed “or equals” as provided for herein. All documents submitted in connection with preparing an “or equal” shall be clearly and obviously marked as a proposed “or equal” submission.

3.12.3 No approvals or action taken by the Architect or Owner’s Representative shall relieve Contractor from its obligation to ensure that an “or equal” article, appliance, devise or material strictly complies with the requirements of the Contract Documents. Contractor shall not propose “or equal” items in connection with Shop Drawings or other Submittals, and Contractor acknowledges and agrees that no approvals or action taken by the Architect or Owner’s Representative with respect to Shop Drawings or other Submittals shall constitute approval of any “or equal” item or relieve Contractor from its sole and exclusive responsibility. Any changes required in the details and dimensions indicated in the Contract Documents for the incorporation or installation of any “or equal” item supplied by the Contractor shall be properly made and approved by the Architect at the expense of the Contractor. No ‘or equal’ items will be permitted for components of or extensions to existing systems when, in the opinion of the Architect, the named manufacturer must be provided in order to ensure compatibility with the existing systems, including, but not limited to, mechanical systems, electrical systems, fire alarms, smoke detectors, etc. No action will be taken by the Architect with respect to proposed “or equal” items prior to receipt of bids, unless otherwise noted in the Special Conditions.

3.13 Shop Drawings, Product Data, Samples, and Coordination Drawings/BIM Models

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

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

**3.13.3** Samples are physical samples which illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

**3.13.4** Coordination Drawings are drawings for the integration of the Work, including work first shown in detail on shop drawings or product data. Coordination drawings show sequencing and relationship of separate units of work which must interface in a restricted manner to fit in the space provided, or function as indicated. Coordination Drawings are the responsibility of the contractor and are submitted for informational purposes. The Special Conditions will state whether coordination drawings are required. BIM models may be used for coordination in lieu of coordination drawings at the contractor’s discretion, unless required in the Special Conditions. The final coordination drawings/BIM Model will not change the contract documents, unless approved by a fully executed change order describing the specific modifications that are being made to the contract documents.

**3.13.5** Shop Drawings, Coordination Drawings/BIM Models, Product Data, Samples and similar submittals (collectively referred to as “Submittals”) are not Contract Documents. The purpose of their submittal is to demonstrate for those portions of the Work for which submittals are required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

**3.13.6** The Contractor shall schedule submittal of Shop Drawings and Product Data to the Architect so that no delays will result in delivery of materials and equipment, advising the Architect of priority for checking of Shop Drawings and Product Data, but a minimum of two weeks shall be provided for this purpose. Because time is of the essence in this contract, unless noted otherwise in the Special Conditions or Technical Specifications, all submittals, shop drawings and samples must be submitted as required to maintain the contractor’s plan for proceeding, but must be submitted within 90 days of the Notice To Proceed. If Contractor believes that this milestone is unreasonable for any submittal, Contractor shall request an extension of this milestone, within 60 days of Notice To Proceed, for each submittal that cannot meet the milestone. The request shall contain a reasonable explanation as to why the 90 day milestone is unrealistic, and shall specify a date on which the submittal will be transmitted, for approval by the Owner’s Representative. Failure of the Contractor to comply with this section may result in delays in the submittal approval process and/or charges for expediting approval, both of which will be the responsibility of the Contractor.

**3.13.7** The Contractor, at its own expense, shall submit Samples required by the Contract Documents with reasonable promptness as to cause no delay in the Work or the activities of separate contractors and no later than twenty (20) days before materials are required to be ordered for scheduled delivery to the Work site. Samples shall be labeled to designate material or products represented, grade, place of origin, name of producer, name of Contractor and the name and number of the Owner’s project. Quantities of Samples shall be twice the number required for testing so that Architect can return one set of the Samples. Materials delivered before receipt of Architect’s approval may be rejected by Architect and in such event, Contractor shall immediately remove all such materials from the Work site. When requested by Architect or Owner’s Representative, samples of finished masonry and field applied paints and finishes shall be located as directed and shall include sample panels built at the site of approximately twenty (20) square feet each.

**3.13.8** The Contractor shall perform no portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been approved by the Architect. Such Work shall be in accordance with approved submittals.

**3.13.9** By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents such Submittals strictly comply with the requirements of the Contract Documents and that the Contractor has determined and verified field measurements and field construction criteria related thereto, that materials are fit for their intended use and that the fabrication, shipping, handling, storage, assembly and installation of all materials, systems and equipment are in accordance with best practices in the industry and are in strict compliance with any applicable requirements of the Contract Documents. Contractor shall also coordinate each Submittal with other Submittals.

**3.13.10** Contractor shall be responsible for the correctness and accuracy of the dimensions, measurements and other information contained in the Submittals.

**3.13.11** Each Submittal will bear a stamp or specific indication that the Submittal complies with the Contract Documents and Contractor has satisfied its obligations under the Contract Documents with respect to Contractor’s review and approval of that Submittal. Each Submittal shall bear the signature of the representative of Contractor who approved the Submittal, together with the Contractor’s name, Owner’s name, number of the Project, and the item name and specification section number.

**3.13.12** The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data,
Samples or similar submittals. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Architect's approval thereof. Specifically, but not by way of limitation, Contractor acknowledges that Architect's approval of Shop Drawings shall not relieve Contractor for responsibility for errors and omissions in the Shop Drawings since Contractor is responsible for the correctness of dimensions, details and the design of adequate connections and details contained in the Shop Drawings.

3.13.13 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Architect on previous Submittals.

3.13.14 The Contractor represents and warrants that all Shop Drawings shall be prepared by persons and entities possessing expertise and experience in the trade for which the Shop Drawing is prepared and, if required by the Architect or applicable Laws, by a licensed engineer or other design professional.

3.14 Record Drawings

3.14.1 The Contractor shall maintain a set of Record Drawings on site in good condition and shall use colored pencils to mark up said set with "record information" in a legible manner to show: (1) bidding addendums, (2) executed change orders, (3) deviations from the Drawings made during construction; (4) details in the Work not previously shown; (5) changes to existing conditions or existing conditions found to differ from those shown on any existing drawings; (6) the actual installed position of equipment, piping, conduits, light switches, electric fixtures, circuiting, ducts, dampers, access panels, control valves, drains, openings, and stub-outs; and (7) such other information as either Owner or Architect may reasonably request. The prints for Record Drawing use will be a set of "blue line" prints provided by Architect to Contractor at the start of construction. Upon Substantial Completion of the Work, Contractor shall deliver all Record Drawings to Owner and Architect for approval. If not approved, Contractor shall make the revisions requested by Architect or Owner's Representative. Final payment and any retainage shall not be due and owing to Contractor until the final Record Drawings marked by Contractor as required above are delivered to Owner.

3.15 Operating Instructions and Service Manuals

3.15.1 The Contractor shall submit four (4) volumes of operating instructions and service manuals to the Architect before completing 50% of the adjusted contract amount. Payments beyond 50% of the adjusted contract amount may be withheld until all operating instructions and service manuals are received. The operating instructions and service manuals shall contain:

.1 Start-up and Shutdown Procedures: Provide a step-by-step write up of all major equipment. When manufacturer's printed start-up, trouble shooting and shut-down procedures are available, they may be incorporated into the operating manual for reference.

.2 Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.

.3 Equipment List: List of all major equipment as installed shall include model number, capacities, flow rate, and name-plate data.

.4 Service Instructions: The Contractor shall be required to provide the following information for all pieces of equipment.

(a) Recommended spare parts including catalog number and name of local suppliers or factory representative.

(b) Belt sizes, types, and lengths.

(c) Wiring diagrams.

.5 Manufacturer's Certificate of Warranty: Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year from the date of Substantial Completion. Where longer period is required by the Contract Documents, the longer period shall govern.

.6 Parts catalogs: For each piece of equipment furnished, a parts catalog or similar document shall be provided which identifies the components by number for replacement ordering.

3.15.2 Submission

.1 Manuals shall be bound into volumes of standard 8 1/2" x 11" hard binders. Large drawings too bulky to be folded into 8 1/2" x 11" shall be separately bound or folded and in brown envelopes, cross-referenced and indexed with the manuals.

.2 The manuals shall identify the Owner's project name, project number, and include the name and address of the Contractor and major Subcontractors of any tier who were involved with the activity described in that particular manual.

3.16 Taxes

3.16.1 The Contractor shall pay all applicable sales, consumer, use, and similar taxes for the Work which are legally enacted when the bids are received, whether or not yet effective or scheduled to go into effect. However, certain purchases by the Contractor of materials incorporated in or consumed in the Work are exempt from certain sales tax pursuant to RSMo § 144.062. The Contractor shall be issued a Project Tax Exemption Certificate for this Work to obtain the benefits of RSMo § 144.062.

3.16.2 The Contractor shall furnish this certificate to all subcontractors, and any person or entity purchasing materials
Contract Documents, shall be revised on a monthly basis or schedule shall not exceed time limits current under the Work and Work Milestone Dates as defined herein. The interim dates for completion of various components of the construction schedule for the Work and shall set forth for the Owner's and Architect's information Contractor's issuance of the Notice to Proceed, shall prepare and submit 3.17.1 The Contractor, within fifteen (15) days after the conditions of the Work, and shall provide for expeditious and practicable execution of the Work. The Contractor shall conform to the most recent schedule.

3.17.2 The construction schedule shall be in a detailed format satisfactory to the Owner's Representative and the Architect and in accordance with the detailed schedule requirements set forth in this document and the Special Conditions. If the Owner's Representative or Architect has a reasonable objection to the schedule submitted by Contractor, the construction schedule shall be promptly revised by the Contractor. The Contractor shall monitor the progress of the Work for conformance with the requirements of the construction schedule and shall promptly advise the Owner of any delays or potential delays.

3.17.3 As time is of the essence to this contract, the University expects that the Contractor will take all necessary steps to insure that the project construction schedule shall be prepared in accordance with the specific requirements of the Special Conditions to this contract. At a minimum, contractor shall comply with the following:

1. The schedule shall be prepared using Primavera P3, Oracle P6, Microsoft Project or other software acceptable to the Owner's Representative.

2. The schedule shall be prepared and maintained in CPM format, in accordance with Construction CPM Scheduling, published by the Associated General Contractors of American (AGC).

3. Prior to submittal to the Owner’s Representative for review, Contractor shall obtain full buy-in to the schedule from all major subcontractors, in writing if so requested by Owner's Representative.

4. Schedule shall be updated, in accordance with Construction CPM Scheduling, published by the AGC, on a monthly basis at minimum, prior to, and submitted with, the monthly pay application or as requested by the Owner’s Representative.

5. Along with the update the Contractor shall submit a narrative report addressing all changes, delays and impacts, including weather to the schedule during the last month, and explain how the end date has been impacted by same.

6. The submission of the updated certifies that all delays and impacts that have occurred on or to the project during the previous month have been factored into the update and are fully integrated into the schedule and the projected completion date.

Failure to comply with any of these requirements will be considered a material breach of this contract. See Special Conditions for detailed scheduling requirements.

3.17.4 In the event the Owner’s Representative or Architect determines that the performance of the Work, as of a Milestone Date, has not progressed or reached the level of completion required by the Contract Documents, the Owner shall have the...
right to order the Contractor to take corrective measures necessary to expedite the progress of construction, including, without limitation, (1) working additional shifts or overtime, (2) supplying additional manpower, equipment, facilities, (3) expediting delivery of materials, and (4) other similar measures (hereinafter referred to collectively as Extraordinary Measures). Such Extraordinary Measures shall continue until the progress of the Work complies with the stage of completion required by the Contract Documents. The Owner's right to require Extraordinary Measures is solely for the purpose of ensuring the Contractor's compliance with the construction schedule. The Contractor shall not be entitled to an adjustment in the Contract Sum concerning Extraordinary Measures required by the Owner under or pursuant to this Paragraph 3.17.3. The Owner may exercise the rights furnished the Owner under or pursuant to this Paragraph 3.17.3 as frequently as the Owner deems necessary to ensure that the Contractor's performance of the Work will comply with any Milestone Date or completion date set forth in the Contract Documents.

ARTICLE 4
ADMINISTRATION OF THE CONTRACT

4.1 Rights of the Owner
4.1.1 The Owner's Representative will administer the Construction Contract. The Architect will assist the Owner's Representative with the administration of the Contract as indicated in these Contract Documents.

4.1.2 If, in the judgment of the Owner's Representative, it becomes necessary to accelerate the work, the Contractor, when directed by the Owner's Representative in writing, shall cease work at any point and transfer its workers to such point or points and execute such portions of the work as may be required to enable others to hasten and properly engage and carry out the work, all as directed by the Owner's Representative. The additional cost of accelerating the work, if any, will be borne by the Owner, unless the Contractor's work progress is behind schedule as shown on the most recent progress schedule.

4.1.3 If the Contractor refuses, for any reason, to proceed with what the Owner believes to be contract work, the Owner may issue a Construction Directive, directing the Contractor to proceed. Contractor shall be obligated to promptly proceed with this work. If Contractor feels that it is entitled to additional compensation for this work, it may file a claim for additional compensation and/or time, in accordance with 4.4 of this document.

4.1.4 The Owner's Representative, may, by written notice, require a Contractor to remove from involvement with the Work, any of Contractor’s personnel or the personnel of its Subcontractors of any tier whom the Owner's Representative may deem abusive, incompetent, careless, or a hindrance to proper and timely execution of the Work. The Contractor shall comply with such notice promptly, but without detriment to the Work or its progress.

4.1.5 The Owner's Representative will schedule Work status meetings that shall be attended by representatives of the Contractor and appropriate Subcontractors of any tier. Material suppliers shall attend status meetings if required by the Owner's Representative. These meetings shall include preconstruction meetings.

4.1.6 The Owner does not allow smoking on University property.

4.2 Rights of the Architect
4.2.1 The Architect will interpret requirements of the Contract Documents with respect to the quality, quantity and other technical requirements of the Work itself within a reasonable time after written request of the Contractor. Contractor shall provide Owner’s Representative a copy of such written request.

4.3 Review of the Work
4.3.1 The Architect and the Owner's Representative shall, at all times, have access to the Work; and the Contractor shall provide proper and safe facilities for such access.

4.3.2 The Owner’s Representative shall have authority to reject Work that does not strictly comply with the requirements of the Contract Documents. Whenever the Owner’s Representative considers it necessary or advisable for implementation of the intent of the Contract Documents, Owner’s Representative shall have the authority to require additional inspection or testing of the Work, whether or not such Work is fabricated, installed or completed.

4.3.3 The fact that the Architect or the Owner's Representative observed, or failed to observe, faulty Work, or Work done which is not in accordance with the Contract Documents, regardless of whether or not the Owner has released final payment, shall not relieve the Contractor from responsibility for all damages and additional costs of the Owner as a result of defective or faulty Work.

4.4 Claims
4.4.1 A Claim is a demand or assertion by Contractor seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or any other relief with respect to the terms of the Contract. The term "Claim(s)" also includes demands and assertions of Contractor arising out of or relating to the Contract Documents, including Claims based upon breach of contract, mistake, misrepresentation, or other cause for Contract Modification or
4.4.2 Claims by Contractor must be made promptly, and no later than within fourteen (14) days after occurrence of the event giving rise to such Claim. Claims must be made by written notice. Such notice shall include a detailed statement setting forth all reasons for the Claim and the amount of additional money and additional time claimed by Contractor. The notice of Claims shall also strictly comply with all other provisions of the Contract Documents. Contractor shall not be entitled to rely upon any grounds or basis for additional money or additional time not specifically set forth in the notice of Claim. All Claims not made in the manner provided herein shall be deemed waived and of no effect. Contractor shall furnish the Owner and Architect such timely written notice of any Claim provided for herein, including, without limitation, those in connection with alleged concealed or unknown conditions, and shall cooperate with the Owner and Architect in any effort to mitigate the alleged or potential damages, delay or other adverse consequences arising out of the condition which is the cause of such a Claim.

4.4.3 Pending final resolution of a Claim, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments that are not in dispute in accordance with the Contract Documents.

4.5 Claims for Concealed or Unknown Conditions

4.5.1 If conditions are encountered at the site which are (1) subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents, or (2) unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, then notice by the Contractor shall be given to the Owner's Representative promptly before conditions are disturbed, and in no event later than three (3) days after first observance of the conditions. The Owner's Representative will promptly investigate such conditions. If such conditions differ materially, as provided for above and cause an increase or decrease in the Contractor’s cost, or time, required for performance of the Work, an equitable adjustment in the Contract sum or Contract Time, or both, shall be made, subject to the provisions and restrictions set for herein. If the Owner's Representative determines that the conditions at the site are not materially different from those indicated in the Contract Documents, and that no change in the terms of the Contract is justified, the Owner's Representative will so notify the Contractor in writing. If the Contractor disputes the finding of the Owner’s Representative that no change in the terms of the Contract terms is justified, Contractor shall proceed with the Work, taking whatever steps are necessary to overcome or correct such conditions so that Contractor can proceed in a timely manner. The Contractor may have the right to file a Claim in accordance with the Contract Documents.

4.5.2 It is expressly agreed that no adjustment in the Contract Time or Contract Sum shall be permitted, however, in connection with a concealed or unknown condition which does not differ materially from those conditions disclosed or which reasonably should have been disclosed by the Contractor’s (1) prior inspections, tests, reviews and preconstruction investigations for the Project, or (2) inspections, tests, reviews and preconstruction inspections which the Contractor had the opportunity to make or should have performed in connection with the Project.

4.6 Claim for Additional Cost

4.6.1 If the Contractor makes a Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. In addition to all other requirements for notice of a Claim, said notice shall detail and itemize the amount of all Claims and shall contain sufficient data to permit evaluation of same by Owner.

4.7 Claims for Additional Time

4.7.1 If the Contractor makes a Claim for an increase in the Contract Time, written notice as provided herein shall be given in addition to other requirements for notice of a Claim, Contractor shall include an estimate of the probable effect of delay upon the progress of the Work, utilizing a CPM Time Impact Schedule Analysis, (TIA) as defined in the AGC Scheduling Manual. In the case of a continuing delay, only one Claim is necessary.

.1 Time extensions will be considered for excusable delays only. That is, delays that are beyond the control and/or contractual responsibility of the contractor.

4.7.2 If weather days are the basis for a Claim for additional time, such Claim shall be documented by the Contractor by data acceptable to the Owner's Representative substantiating that weather conditions for the period of time in question, had an adverse effect on the critical path of the scheduled construction. Weather days shall be defined as days on which critical path work cannot proceed due to weather conditions (including but not limited to rain, snow, etc.), in excess of the number of days shown on the Anticipated Weather Day schedule in the Special Conditions. To be considered a weather day, at least four hours must be lost due to the weather conditions on a critical path scope item for that day. Weather days and Anticipated weather days listed in the Special Conditions shall only apply to Monday through Friday. A weather day claim cannot be made for Saturdays, Sundays, New Year’s Day, Martin Luther King Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the day after Thanksgiving Day and
The Contractor must have fulfilled its contract obligations with respect to temporary facilities and protection of its work; and worker protection for hot and cold weather per OSHA guidelines.

If the contract obligations have been satisfied, the Owner will review requests for non-compensable time extensions for critical path activities as follows:

.2.1 If the Contractor cannot work on a critical path activity due to adverse weather, after implementing all reasonable temporary weather protection, the Contractor will so notify the Owner’s Representative. Each week, the Contractor will notify the Owner’s Representative of the number of adverse weather days that it believes it has experienced in the previous week. As provided in the contract, until such time as the weather days acknowledged by the Owner’s Representative exceed the number of days of adverse weather contemplated in the Special Conditions, no request for extension of the contract completion time will be considered.

.2.2 If the Contractor has accumulated in excess of the number of adverse weather days contemplated in the Special Conditions due to the stoppage of work on critical path activities due to adverse weather, the Owner will consider a time extension request from the Contractor that is submitted in accordance with the contract requirements. The Owner will provide a change order extending the time for contract completion or direct an acceleration of the work in accordance with the contract terms and conditions to recover the time lost due to adverse weather in excess of the number of adverse weather working days contemplated in the Special Conditions.

4.7.3 If any other Force Majeure event results in the delay to the critical path of the project, the Owner will consider a time extension request from the Contractor that is submitted in accordance with the contract requirements.

4.7.4 The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor’s updated schedule, in conjunction with the monthly application for payment.

4.8 Resolution of Claims and Disputes

4.8.1 The Owner's Representative will review Claims and take one or more of the following preliminary actions within ten days of receipt of a Claim: (1) request additional supporting data from the Contractor, (2) reject the Claim in whole or in part, (3) approve the Claim, or (4) suggest a compromise.

4.8.2 If a Claim has not been resolved, the Contractor shall, within ten days after the Owner's Representative's preliminary response, take one or more of the following actions: (1) submit additional supporting data requested, (2) modify the initial Claim, or (3) notify the Owner's Representative that the initial Claim stands.

4.8.3 If a Claim has not been resolved after consideration of the foregoing and of further information presented by the Contractor, the Contractor has the right to seek administrative review as set forth in Section 4.9. However, Owner’s Representative’s decisions on matters relating to aesthetics will be final.

4.9 Administrative Review

4.9.1 Claims not resolved pursuant to the procedures set forth in the Contract Documents except with respect to Owner's Representative’s decision on matters relating to aesthetic effect, and except for claims which have been waived by the making or acceptance of final payment, or the Contractor's acceptance of payments in full for changes in work may be submitted to administrative review as provided in this section. All requests for administrative review shall be made in writing.

4.9.2 Upon written request from the Contractor, the Owner’s Review Administrator authorized by the Campus Contracting Officer will convene a review meeting between the Contractor and Owner’s Representative’s within fifteen (15) days of receipt of such written request. The Contractor and Owner’s Representative will be allowed to present written documentation with respect to the claim(s) before or during the meeting. The Contractor and Owner’s Representative will be allowed to present the testimony of any knowledgeable person regarding the claim at the review meeting. The Owner’s Review Administrator will issue a written summary of the review meeting and decision to resolve the Claim within fifteen (15) days. If the Contractor is in agreement with the decision the Contractor shall notify the Owner’s Review Administrator in writing within five (5) days, and appropriate documentation will be signed by the parties to resolve the Claim.

4.9.3 If the Contractor is not in agreement with the proposal of the Owner's Review Administrator as to the resolution of the claim, the Contractor may file a written appeal with the UM System Contracting Officer, [in care of the Director of Facilities Planning and Development,
The UM System Contracting Officer will call a meeting of the Contractor, the Owner’s Representative, and the Owner’s Review Administrator by written notice, within thirty (30) days after receipt of the Contractor's written appeal. The Owner’s Review Administrator shall provide the UM System Contracting Officer with a copy of the written decision and summary of the review meeting, the Contractor's corrections or comments regarding the summary of the review meeting, and any written documentation presented by the Contractor and the Owner’s Representative at the initial review meeting. The parties may present further documentation and/or present the testimony of any knowledgeable person regarding the claim at the meeting called by the UM System Contracting Officer.

4.9.4 The UM System Contracting Officer will issue a written decision to resolve the claim within fifteen (15) days after the meeting. If the Contractor is in agreement with the UM System Contracting Officer's proposal, the Contractor shall notify the UM System Contracting Officer in writing within five (5) days, and the Contractor and the Owner shall sign appropriate documents. The issuance of the UM System Contracting Officer's written proposal shall conclude the administrative review process even if the Contractor is not in agreement. However, proposals and any opinions expressed in such proposals issued under this section will not be binding on the Contractor nor will the decisions or any opinions expressed be admissible in any legal actions arising from the Claim and will not be deemed to remove any right or remedy of the Contractor as may otherwise exist by virtue of Contract Documents or law. Contractor and Owner agree that the Missouri Circuit Court for the County where the Work is located shall have exclusive jurisdiction to determine all issues between them. Contractor agrees not to file any complaint, petition, lawsuit or legal proceeding against Owner except with such Missouri Circuit Court.

ARTICLE 5
SUBCONTRACTORS

5.1 Award of Subcontracts

5.1.1 Pursuant to Article 9, the Contractor shall furnish the Owner and the Architect, in writing, with the name, and trade for each Subcontractor and the names of all persons or entities proposed as manufacturers of products, materials and equipment identified in the Contract Documents and where applicable, the name of the installing contractor. The Owner’s Representative will reply to the Contractor in writing if the Owner has reasonable objection to any such proposed person or entity. The Contractor shall not contract with a proposed person or entity to whom the Owner has made reasonable and timely objection.

5.1.2 The Contractor may request to change a subcontractor. Any such request shall be made in writing to the Owner’s Representative. The Contractor shall not change a Subcontractor, person, or entity previously disclosed if the Owner makes reasonable objection to such change.

5.1.3 The Contractor shall be responsible to the Owner for acts, defaults, and omissions of its Subcontractors of any tier.

5.2 Subcontractual Relations

5.2.1 By appropriate agreement, written where legally required for validity, the Contractor shall require each Subcontractor of any tier, to the extent of the Work to be performed by the Subcontractor of any tier, to be bound to the Contractor by terms of the Contract Documents and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these Documents, assumes toward the Owner and the Architect. Each subcontract agreement of any tier shall preserve and protect the rights of the Owner and the Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor of any tier so that subcontracting thereof will not prejudice such rights and shall allow to the Subcontractor of any tier, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with its sub-subcontractors. The Contractor shall make available to each proposed Subcontractor of any tier, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor of any tier shall be bound. Subcontractors of any tier shall similarly make copies of applicable portions of such documents available to their respective proposed Subcontractors of any tier.

5.2.2 All agreements between the Contractor and a Subcontractor or supplier shall contain provisions whereby Subcontractor or supplier waives all rights against the Owner, contractor, Owner’s representative, Architect and all other additional insureds for all losses and damages caused by, arising out of, or resulting from any of the perils covered by property or builders risk insurance coverage required of the Contractor in the Contract Documents. If Contractor fails to include said provisions in all subcontracts, Contractor shall indemnify, defend and hold all the above entities harmless in the event of any legal action by Subcontractor or supplier. If insureds on any such policies require separate

University of Missouri, 109 Old Alumni Centers, University of Missouri, Columbia, Missouri 65211] within fifteen (15) days after receipt of the Owner’s Review Administrator’s proposal. The UM System Contracting Officer will issue a written decision to resolve the claim within fifteen (15) days after the meeting. If the Contractor is in agreement with the UM System Contracting Officer's proposal, the Contractor shall notify the UM System Contracting Officer in writing within five (5) days, and the Contractor and the Owner shall sign appropriate documents. The issuance of the UM System Contracting Officer's written proposal shall conclude the administrative review process even if the Contractor is not in agreement. However, proposals and any opinions expressed in such proposals issued under this section will not be binding on the Contractor nor will the decisions or any opinions expressed be admissible in any legal actions arising from the Claim and will not be deemed to remove any right or remedy of the Contractor as may otherwise exist by virtue of Contract Documents or law. Contractor and Owner agree that the Missouri Circuit Court for the County where the Work is located shall have exclusive jurisdiction to determine all issues between them. Contractor agrees not to file any complaint, petition, lawsuit or legal proceeding against Owner except with such Missouri Circuit Court.

ARTICLE 5
SUBCONTRACTORS

5.1 Award of Subcontracts

5.1.1 Pursuant to Article 9, the Contractor shall furnish the Owner and the Architect, in writing, with the name, and trade for each Subcontractor and the names of all persons or entities proposed as manufacturers of products, materials and equipment identified in the Contract Documents and where applicable, the name of the installing contractor. The Owner’s Representative will reply to the Contractor in writing if the Owner has reasonable objection to any such proposed person or entity. The Contractor shall not contract with a proposed person or entity to whom the Owner has made reasonable and timely objection.

5.1.2 The Contractor may request to change a subcontractor. Any such request shall be made in writing to the Owner’s Representative. The Contractor shall not change a Subcontractor, person, or entity previously disclosed if the Owner makes reasonable objection to such change.

5.1.3 The Contractor shall be responsible to the Owner for acts, defaults, and omissions of its Subcontractors of any tier.

5.2 Subcontractual Relations

5.2.1 By appropriate agreement, written where legally required for validity, the Contractor shall require each Subcontractor of any tier, to the extent of the Work to be performed by the Subcontractor of any tier, to be bound to the Contractor by terms of the Contract Documents and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these Documents, assumes toward the Owner and the Architect. Each subcontract agreement of any tier shall preserve and protect the rights of the Owner and the Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor of any tier so that subcontracting thereof will not prejudice such rights and shall allow to the Subcontractor of any tier, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with its sub-subcontractors. The Contractor shall make available to each proposed Subcontractor of any tier, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor of any tier shall be bound. Subcontractors of any tier shall similarly make copies of applicable portions of such documents available to their respective proposed Subcontractors of any tier.

5.2.2 All agreements between the Contractor and a Subcontractor or supplier shall contain provisions whereby Subcontractor or supplier waives all rights against the Owner, contractor, Owner’s representative, Architect and all other additional insureds for all losses and damages caused by, arising out of, or resulting from any of the perils covered by property or builders risk insurance coverage required of the Contractor in the Contract Documents. If Contractor fails to include said provisions in all subcontracts, Contractor shall indemnify, defend and hold all the above entities harmless in the event of any legal action by Subcontractor or supplier. If insureds on any such policies require separate
waiver forms to be signed by any Subcontractors of any tier or suppliers, Contractor shall obtain the same.

5.3 Contingent Assignment of Subcontract
5.3.1 No assignment by the Contractor of any amount or any part of the Contract or of the funds to be received thereunder will be recognized unless such assignment has had the written approval of the Owner, and the surety has been given due notice of such assignment and has furnished written consent hereto. In addition to the usual recitals in assignment Contracts, the following language must be set forth: "it is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor of the contract and to claims and to liens for services rendered or materials supplied for the performance of the Work called for in said contract in favor of all persons, firms or corporations rendering such services or supplying such materials."

ARTICLE 6
SEPARATE CONTRACTS AND COOPERATION

6.1 The Owner reserves the right to let other contracts in connection with the Work.

6.2 It shall be the duty of each Contractor to whom Work may be awarded, as well as all Subcontractors of any tier employed by them, to communicate immediately with each other in order to schedule Work, locate storage facilities, etc., in a manner that will permit all Contractors to work in harmony in order that Work may be completed in the manner and within the time specified in the Contract Documents.

6.3 No Contractor shall delay another Contractor by neglecting to perform his work at the proper time. Each Contractor shall be required to coordinate his work with other Contractors to afford others reasonable opportunity for execution of their work. Any costs caused by defective or ill-timed work, including actual damages and liquidated damages for delay, if applicable, shall be borne by the Contractor responsible therefor.

6.4 Each Contractor shall be responsible for damage to Owner's or other Contractor's property done by him or persons in his employ, through his or their fault or negligence. If any Contractor shall cause damage to any other Contractor, the Contractor causing such damage shall upon notice of any claim, settle with such Contractor.

6.5 The Contractor shall not claim from the Owner money damages or extra compensation under this Contract when delayed in initiating or completing his performance hereunder, when the delay is caused by labor disputes, acts of God, or the failure of any other Contractor to complete his performance under any Contract with the Owner, where any such cause is beyond the Owner's reasonable control.

6.6 Progress schedule of the Contractor for the Work shall be submitted to other Contractors as necessary to permit coordinating their progress schedules.

6.7 If Contractors or Subcontractors of any tier refuse to cooperate with the instructions and reasonable requests of other contractors performing work for the Owner under separate contract, in the overall coordinating of the Work, the Owner's Representative may take such appropriate action and issue such instructions as in his judgement may be required to avoid unnecessary and unwarranted delay.

ARTICLE 7
CHANGES IN THE WORK

7.1 CHANGE ORDERS
7.1.1 A change order is a written instrument prepared by the Owner and signed by the Owner and Contractor formalizing their agreement on the following:

.1 a change in the Work
.2 the amount of an adjustment, if any, in the Contract amount
.3 an adjustment, if any, in the Contract time

7.1.2 The Owner may at any time, order additions, deletions, or revisions in the Work by a Change Order or a Construction Change Directive. Such Change Order or Construction Change Directive shall not invalidate the Contract and requires no notice to the surety. Upon receipt of any such document, or written authorization from the Owner’s Representative directing the Contractor to proceed pending receipt of the document, Contractor shall promptly proceed with the Work involved in accordance with the terms set forth therein.

7.1.3 Until such time as the change order is formalized and signed by both the Owner and the Contractor it shall be considered a Change Order Request.

7.1.4 The amount of adjustment in the contract price for authorized Change Orders will be agreed upon before such Change Orders becomes effective and will be determined as follows:

.1 By a lump sum proposal from the Contractor and the Subcontractors of any tier, including overhead and profit.
.2 By a time and material basis with or without a specified maximum. The Contractor shall submit to the Owner’s Representative itemized time and material sheets depicting labor, materials, equipment utilized in completing the Work on a daily basis for the Owner's Representative approval. If this pricing option is utilized, the
Contractor may be required to submit weekly reports summarizing costs to date on time and material change orders not yet finalized.

By unit prices contained in the Contractor's original bid and incorporated in the Construction Contract or subsequently agreed upon. Such unit prices contained in the Contractor's original proposal are understood to include the Contractor's overhead and profit. If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are so changed in a proposed Change Order that application of such unit prices to quantities of the Work proposed will cause substantial inequity to the Owner or to the Contractor, the applicable unit prices shall be equitably adjusted.

7.1.5 The Contractor shall submit all fully documented change order requests with corresponding back-up documentation within the time requested by the Owner but no later than fourteen (14) working days following 1.) the Owner's request for change order pricing in the case of a lump sum; or 2.) the completion of unit price or time and material work.

7.1.6 The Contractor shall submit change order requests in sufficient detail to allow evaluation by the Owner. Such requests shall be fully itemized by units of labor, material and equipment and overhead and profit. Such breakdowns shall be itemized as follows:

1. Labor: The Contractor's proposal shall include breakdowns by labor, by trade, indicating number of hours and cost per hour for each Subcontractor as applicable. Such breakdowns shall only include employees in the direct employ of Contractor or Subcontractors in the performance of the Work. Such employees shall only include laborers at the site, mechanics, craftsmen and foremen. Payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor or Subcontractors. Any item or expense outside of these categories is not allowed. The expense of performing Work after regular working hours, on Saturdays, Sundays or legal holidays shall not be included in the above, unless approved in writing and in advance by Owner.

2. Material, supplies, consumables and equipment to be incorporated into the Work at actual invoice cost to the Contractor or Subcontractors; breakdowns showing all material, installed equipment and consumables fully itemized with number of units installed and cost per unit extended. Any singular item or items in aggregate greater than one thousand dollars ($1,000) in cost shall be supported with supplier invoices at the request of the Owner's Representative. Normal hand tools are not compensable.

3. Equipment: Breakdown for required equipment shall itemize (at a minimum) delivery / pick-up charge, hourly rate and hours used. Operator hours and rate shall not be included in the equipment breakdown. Contractor must use the most cost effective equipment available in the area and should not exceed the rates listed in the Rental Rate Blue Book for Construction Equipment (Blue Book). Contractor shall submit documentation for the Blue Book to support the rate being requested.

7.2 Construction Change Directive

7.2.1 A construction change directive is a written order prepared and signed by the Owner, issued with supporting documents prepared by the Architect (if applicable), directing a change in the Work prior to agreement on adjustment of the Contract amount or Contract time, or both. A Construction Change Directive shall be used in the absence of complete agreement between the Owner and Contractor on the terms of a change order. If the Construction Change Directive allows an adjustment of the contract amount or time, such adjustment amount shall be based on one of the following methods:

1. A lump sum agreement, properly itemized and supported by substantiating documents of sufficient detail to allow evaluation.

2. By unit prices contained in the Contractor's original proposal and incorporated in the Construction Contract or subsequently agreed upon.

3. A method agreed to by both the Owner and the contractor with a mutually agreeable fee for overhead and profit.

4. In the absence of an agreement between the Owner and the Contractor on the method of establishing an adjustment of the contract amount, the Owner, with the assistance of the architect, shall determine the adjustment amount on the basis of expenditures by the Contractor for labor, materials, equipment and other costs consistent with other provisions of the Contract. The contractor shall keep and submit to the Owner an itemized accounting of all cost components, either expended or saved, while performing the Work covered under the Construction Change Directive.

7.2.2 Upon receipt of a Construction Change Directive, Contractor shall promptly proceed with the change in the Work involved and advise Owner of Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum, Contract Time or both.

7.2.3 A Construction Change Directive signed by Contractor indicates the agreement of the Contractor therewith, including adjustment in Contract Sum and Contract Time or the method for determining them.
Such agreement shall be effective immediately and shall be recorded as a Change Order.

7.3 Overhead and Profit

7.3.1 Overhead and Profit on Change Orders shall be applied as follows:

.1 The overhead and profit charged by the Contractor and Subcontractors shall be considered to include, but not limited to, job site office and clerical expense, normal hand tools, incidental job supervision, field supervision, payroll costs and other compensation for project manager, officers, executives, principals, general managers, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, time-keepers, and other personnel employed whether at the site or in principal or a branch office for general superintendent and administration of the Work.

.2 The percentages for overhead and profit charged on Change Orders shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved but in no case shall exceed the following:

15% To the Contractor or the Subcontractor of any tier for Work performed with their respective forces or materials purchased
5% To the Contractor on Work performed by other than his forces
5% To first tier Subcontractor on Work performed by his Subcontractor

.3 The Contractor will be allowed to add 2% for the cost of bonding and insurance to their cost of work. This 2% shall be allowed on the total cost of the added work, including overhead and profit.

.4 Not more than three mark-ups, not to exceed individual maximums shown above, shall be allowed regardless of the number of tier subcontractors. Overhead and profit shall be shown separately for each subcontractor of any tier and the Contractor.

.5 On proposals covering both increases and decreases in the amount of the Contract, the application of overhead and profit shall be on the net change in direct cost for the Contractor or Subcontractor of any tier performing the Work.

.6 The percentages for overhead and profit credit to the Owner on Change Orders that are strictly decreases in the quantity of work or materials shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved, but shall not be less than the following:

Overhead and Profit
7.5% Credit to the Owner from the Contractor or Subcontractor of any tier for Work performed with their respective forces or materials purchased
2.5% Credit to the Owner from the Contractor on Work performed by other than his forces
2.5% Credit to the Owner from the first tier Subcontractor on Work performed by his Subcontractor of any tier

7.4 Extended General Conditions

7.4.1 The Contractor acknowledges that the percentage mark-up allowed on change orders for overhead and profit cover the Contractor’s cost of administering and executing the Work, inclusive of change orders that increase the contract time. Contractor further acknowledges that no compensation beyond the specified mark-up percentages for extended overhead shall be due or payable as a result of an increase in the Contract Time.

7.4.2 The Owner may reimburse the Contractor for extended overhead if an extension of the Contract Time is granted by the Owner, in accordance with Article 4.7.1 and the Owner determines that the extension of the Contract Time creates an inequitable condition for the Contractor. If these conditions are determined by the Owner to exist the Contractor may be reimbursed by unit prices contained in the Contractor's original bid and incorporated in the Construction Contract or by unit prices subsequently agreed upon.

7.4.3 If unit prices are subsequently agreed upon, the Contractor’s compensation shall be limited as follows:

.1 For the portion of the direct payroll cost of the Contractor’s project manager expended in completing the Work and the direct payroll cost of other onsite administrative staff not included in Article 7.3.1. Direct payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor;

.2 Cost of Contractor’s temporary office, including temporary office utilities expense;

.3 Cost of temporary utilities required in the performance of the work;

.4 Profit not to exceed 5% of the total extended overhead direct costs;

7.4.4 All costs not falling into one of these categories and costs of the Contractors staff not employed onsite are not allowed.

7.5 Emergency Work

7.5.1 If, during the course of the Work, the Owner has need to engage the Contractor in emergency work, whether related to the Work or not, the Contractor shall immediately
proceed with the emergency work as directed by the Owner under the applicable provisions of the contract. In so doing, Contractor agrees that all provisions of the contract remain in full force and effect and the schedule for the Work is not impacted in any way unless explicitly agreed to in writing by the Owner.

ARTICLE 8
TIME

8.1 Progress and Completion

8.1.1 Contractor acknowledges and agrees that time is of the essence of this Contract

8.1.2 Contract Time is the period of time set forth in the Contract for Construction required for Substantial Completion and Final Completion of the entire Work or portions of the Work as defined in the Contract Documents. Time limits stated in the Contract Documents are of the essence of the Contract. The Contract Time may only be changed by a Change Order. By executing the Contract, the Contractor confirms that the Contract Time is a sufficient period for performing the Work in its entirety.

8.1.3 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, prematurely commence operations on the site or elsewhere prior to the effective date of insurance and bonds required by Article 11 to be furnished by the Contractor.

8.1.4 The Contractor shall proceed expeditiously and diligently with adequate forces and shall achieve Substantial Completion and Final Completion within the time specified in the Contract Documents.

8.2 Delay in Completion

8.2.1 The Contractor shall be liable for all of the Owner’s damages for delay in achieving Substantial Completion and/or Final Completion of the entire Work or portions of Work as set forth in the Contract Documents within the Contract Time unless liquidated damages are specifically provided for in the Contract Documents. If liquidated damages are specifically provided for in the Contract for Construction, Contractor shall be liable for such liquidated damages as set forth in Paragraph 8.3.

8.2.2 All time limits stated in the Contract are of the essence of the Contract. However, if the Contractor is delayed at any time in the progress of the Work by any act or neglect of the Owner or by the Owner's Representative, by changes ordered in the Work, by strikes, lockouts, abnormal weather conditions, jurisdictional disputes, or any other causes beyond the Contractor's reasonable control which the Owner's Representative determines may justify delay then, upon submission of the Time Impact Schedule Analysis (TIA) called out in Section 4.7 of these General Conditions, the Contract Time may be extended for a reasonable time to the extent such delay will prevent Contractor from achieving Substantial Completion and/or Final Completion within the Contract Time and if performance of the Work is not, was not or would not have been delayed by any other cause for which the Contractor is not entitled to an extension in the Contract Time under the Contract Documents. It shall be a condition precedent to any adjustment of the Contract Time that Contractor provide the Owner’s Representative with written notice of the cause of delay within seven (7) days from the occurrence of the event or condition which caused the claimed delay. Written notices hereunder shall be in accordance with the applicable provisions of Section 4.7.

8.2.3 The Contractor further acknowledges and agrees that adjustments in the Contract Time will be permitted for a delay only to the extent such delay (1) is not caused, or could not have been anticipated, by the Contractor, (2) could not be limited or avoided by the Contractor's timely notice to the Owner of the delay, (3) prevents Contractor from completing its Work by the Contract Time, and (4) is of a duration not less than one (1) day. Delays attributable to and within the control of a Subcontractor or supplier shall not justify an extension of the Contract Time.

8.2.4 Notwithstanding anything to the contrary in the Contract Documents, except as otherwise noted in these General Conditions, an extension in the Contract Time, to the extent permitted under this Article, shall be the sole remedy of the Contractor for any (1) delay in the commencement, prosecution or completion of the Work, (2) hindrance or obstruction in the performance of the Work, (3) loss of productivity, or (4) other similar claims due to or caused by any events beyond the control of both the Owner and Contractor. In no event shall the Contractor be entitled to any compensation or recovery of any damages or any portion of damages resulting from delays caused by or within the control of Contractor or by acts or omissions of Contractor or its Subcontractors of any tier or delays beyond the control of both Owner and Contractor. If the Contractor contends that delay, hindrance, obstruction or other adverse condition results from acts or omissions of the Owner, the Owner's Representative or the Architect, Contractor shall promptly provide written notice to the Owner. Contractor shall only be entitled to an adjustment in the ContractSum to the extent that such acts or omissions continue after the Contractor's written notice to the Owner of such acts or omissions. The Owner's exercise of any of its rights or remedies under the Contract Documents (including, without limitation, ordering changes in the Work, or directing suspension, rescheduling or correction of the Work) regardless of the extent or frequency of the Owner's exercise of such rights or remedies, shall not be the basis of any Claim for an increase in the Contract Sum or Contract Documents.
Time. In the event Contractor is entitled to an adjustment in the Contract Sum for any delay, hindrance, obstruction or other adverse condition caused by the acts or omissions of the Owner, the Owner’s Representative or the Architect, Contractor shall only be entitled to its actual direct costs caused thereby and Contractor shall not be entitled to and waives any right to special, indirect, or consequential damages including loss of profits, loss of savings or revenues, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar type of damages.

8.2.5 If the Contractor submits a progress report or any construction schedule indicating, or otherwise expressing an intention to achieve completion of the Work prior to any completion date required by the Contract Documents or expiration of the Contract Time, no liability of the Owner to the Contractor for any failure of the Contractor to so complete the Work shall be created or implied. Further, the Contractor acknowledges and agrees that even if Contractor intends or is able to complete the Work prior to the Contract Time, it shall assert no Claim and the Owner shall not be liable to Contractor for any failure of the Contractor, regardless of the cause of the failure, to complete the Work prior to the Contract Time.

8.3 Liquidated Damages
8.3.1 If Liquidated Damages are prescribed on the Bid Form and Special Conditions in the Contract Documents, the Owner may deduct from the Contract Sum and retain as Liquidated Damages, and not as penalty or forfeiture, the sum stipulated in the Contract Documents for each calendar day after the date specified for completion of the Work that the entire Work is not substantially complete and/or finally complete.

8.3.2 The Owner’s Representative shall establish the date of Substantial completion and the date of Final Completion of the Work which shall be conclusive and binding on the Owner and Contractor for the purpose of determining whether or not Liquidated Damages shall be assessed under terms hereof and the sum total amount due.

8.3.3 Liquidated Damages or any matter related thereto shall not relieve the Contractor or his surety of any responsibility or obligation under this Contract.

ARTICLE 9
PAYMENTS AND COMPLETION

9.1 Commencement, Prosecution, and Completion
9.1.1 The Contractor shall commence Work within five (5) days upon the date of a “Notice to Proceed” from the Owner or the date fixed in the Notice to Proceed. Contractor shall prosecute the Work with faithfulness and diligence, and the Contractor shall complete the Work within the Contract Time set forth in the Contract Documents.

9.1.2 The Owner will prepare and forward three (3) copies of the Contract and Performance Bond to the bidder to whom the contract for the Work is awarded and such bidder shall return two (2) properly executed prescribed copies of the Contract and Bond to the Owner.

9.1.3 The construction period, when specified in consecutive calendar days, shall begin when the Contractor receives notice requesting the instruments listed in below. Before the Owner will issue Notice to Proceed to permit the Contractor to begin Work, the Owner shall have received the following instruments, properly executed as described in the Contract Documents. The documents below shall have been received by the Owner within fifteen (15) days after receipt of request for documents:

1. Contract
2. Bond (See Article 11)
3. Insurance (See Article 11)
4. List of Subcontractors of any tier
5. Affirmative Action Plan (see Article 13.4)

9.1.4 In the event Contractor fails to provide Owner such documents, Contractor may not enter upon the site of the Work until such documents are provided. The date the Contractor is required to commence and complete the Work shall not be affected by the Owner denying Contractor access to the site as a result of Contractor’s failure to provide such documents and Contractor shall not be entitled to an adjustment of the Contract Time or Contract sum as a result of its failure to comply with the provisions of this Paragraph.

9.1.5 Contracts executed by partnerships shall be signed by all general partners of the partnership. Contracts signed by corporations shall be signed by the President or Vice President and the Secretary or Assistant Secretary. In case the Assistant Secretary or Vice President signs, it shall be so indicated by writing the word "Asst." or "Vice" in front of the words "Secretary" and "President". The corporate seal of the corporation shall be affixed. For all other types of entities, the Contractor and the person signing the Contract on behalf of Contractor represent and warrant that the person signing the Contract has the legal authority to bind Contractor to the Contract.

9.1.6 Any successful bidder which is a corporation organized in a state other than Missouri or any bidder doing business in the State of Missouri under a fictitious name shall furnish, at no cost to the Owner, no later than the time at which the executed Contract for Construction, the Payment Bond, and the Performance Bond are returned, a properly certified copy of its current Certificate of Authority and License to do business in the State of Missouri. No contract will be executed by the Owner until such certificate is furnished by the bidder, unless there already is on file with
the Owner a current certificate, in which event, no additional certificate will be required during the period of time for which such current certificate remains in effect.

9.1.7 Within fifteen (15) calendar days of the issuance of a Notice to Proceed, the Contractor shall submit one (1) signed copy of the following instruments. No payment will be processed until all of these instruments are received and approved by the Owner’s Representative.

.1 Reproducible progress and payment schedule
.2 Contractor’s Schedule of Values
.3 List of material suppliers
.4 Itemized breakdown of all labor rates for each classification. Overhead and profit shall not be included. Payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor or Subcontractors. Any item or expense outside of these categories is not allowed. The expense of performing Work after regular working hours, on Saturdays, Sundays or legal holidays shall not be included in the above, unless approved in writing and in advance by Owner.
.5 Itemized breakdown of anticipated equipment rates (breakout operator rate). Overhead and profit shall not be included. Breakdown for required equipment shall itemize (at a minimum) delivery/pick-up charge, hourly rate and hours used. Operator hours and rate shall not be included in the equipment breakdown. Contractor must use the most cost effective equipment available in the area and should not exceed the rates listed in the Rental Rate Blue Book for Construction Equipment (Blue Book). Contractor shall submit documentation for the Blue Book to support the rate being requested.

9.1.8 The Contractor shall be paid electronically using the Owner’s web-based payment program with a direct electronic transfer from the Owner’s account into the Contractor’s account. The Contractor must submit the following information to the Owner’s Representative:

.1 Bank Transit Number for the Contractor’s bank into which the electronic deposit will be made.
.2 Bank Account Number for the Contractor’s account into which the electronic deposit will be made.
.3 Contractor’s E-Mail address so that formal notification of the deposit by the Owner can be provided.

9.2 Contract Sum

9.2.1 The Owner shall compensate Contractor for all Work described herein and in the Contract Documents the Contract Sum set forth in the Contract for Construction, subject to additions and deletions as provided hereunder.

9.3 Schedule of Values

9.3.1 Within fifteen (15) days after receipt of the Notice to Proceed, the Contractor shall submit to the Owner’s Representative a schedule of values allocated to various portions of the Work, prepared in such form and supported by such data to substantiate its accuracy as the Owner’s Representative may require. This schedule, unless objected to by the Owner’s Representative, shall be used as a basis for reviewing the Contractor’s Applications for Payment. The values set forth in such schedule may, at the Owner’s option be used in any manner as fixing a basis for additions to or deletions from the Contract Sum.

9.3.2 The progress and payment schedule of values shall show the following:

.1 Enough detail as necessary to adequately evaluate the actual percent complete of any line item on a monthly basis, as determined by the Owner’s Representative.
.2 Line items, when being performed by a subcontractor or material supplier, shall correlate directly back to the subcontract or purchase order amount if requested by the Owner’s Representative.

9.4 Applications for Payment

9.4.1 The Contractor shall submit monthly to the Owner’s Representative and the Architect an itemized Application for Payment for operations completed in accordance with the Schedule of Values. Such application shall be supported by such data substantiating the Contractor’s right to payment as the Owner’s Representative or Architect may require, such as copies of requisitions from Subcontractors and material suppliers, and reflecting retainage as provided for herein.

9.4.2 Such applications shall not include requests for payment of amounts the Contractor does not intend to pay to a Subcontractor or material supplier.

9.4.3 Progress payments shall be made on account of materials and equipment delivered to the site and incorporated in the Work. No payments will be made for materials and equipment stored at the Project site but not yet incorporated into the Work except as provided in Paragraph 9.4.4.

9.4.4 If approved in writing and in advance by Owner, progress payments may be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. Owner may in its sole discretion refuse to grant approval for payments for materials and equipment stored at the Project site but not yet incorporated in the Work. Any approval by Owner for payment for materials and equipment delivered and suitably
stored at the site, or stored offsite as noted below, for subsequent incorporation in the Work shall be conditioned upon Contractor’s demonstrating that such materials and equipment are adequately protected from weather, damage, vandalism and theft and that such materials and equipment have been inventoried and stored in accordance with procedures established by or approved by the Owner. Nothing in this clause shall imply or create any liability on the part of the Owner for the Contractor’s inventory and storage procedures or for any loss or damage to material, equipment or supplies stored on the site, whether incorporated into the work or not. In the event any such loss or damage occurs, the Contractor remains solely responsible for all costs associated with replacement of the affected materials, supplies and equipment including labor and incidental costs, and shall have no claim against the Owner for such loss.

No allowance shall be made in the project pay requests for materials not delivered to the site of the work and incorporated into the work, except as noted below. For the purposes of this Article, Offsite is defined as any location not owned or leased by the Owner. Contractor shall submit a list of materials that they are requesting payment for offsite storage within 60 days of Notice Proceed.

.1 Items considered to be major items of considerable magnitude, if suitably stored, may be allowed in project pay requests on the basis of ninety percent (90%) of invoices

.2 Determination of acceptable “major items of considerable magnitude” and “suitably stored” shall be made by the Owner’s Representative.

.3 Aggregate quantities of materials not considered unique to this project will not be considered for offsite storage payment.

.4 Contractor shall submit to the Owner’s Representative a list of the material for which application for payment for offsite storage is anticipated no less than forty-five days prior to the submission of the applicable pay request. The list shall include a material description, applicable division, quantity and discounts offered to the Owner for early payment. Contractor shall also submit the location the material will be stored and the method of protection.

.5 The storage facility shall be subject to approval by the Owner’s representative, shall be located within an acceptable distance of the project sites as established by the Owner’s Representative and all materials for the Owner’s project must be stored separately from all other items within the storage facility and shall be labeled and stored in the name of the Curators of the University of Missouri.

.6 The Owner’s representative shall be provided a minimum of two weeks tice to visit the storage facility and inspect the stored material prior to submission of the pay request.

.7 Upon favorable inspection by the Owner’s Representative, the Contractor shall, at the Owner’s option, submit the appropriate UCC filing, transferring title of the material or equipment to The Curators of the University of Missouri.

.8 An invoice provided by the supplier shall be included with the applicable pay request.

.9 The contractor shall remain fully responsible for all items, until acceptance of the project by the Owner.

10. The contractor shall reimburse all costs incurred by the Owner in inspecting and verifying all material stored offsite, including mileage, airfare, meals, lodging and time, charged at a reasonable hourly rate.

9.4.5 The Application for Payment shall constitute a representation by the Contractor to the Owner that the Work has progressed to the point indicated; the quality of the Work covered by the Application for Payment is in accordance with the Contract Documents; and the Contractor is entitled to payment in the amount requested.

9.4.6 The Contractor will be reimbursed for ninety-five percent (95%) of the value of all labor furnished and material installed and computed in the same manner, less all previous payments made. On projects where a bond is not required, the contractor will be reimbursed for ninety percent (90%) of the value of all labor furnished and material installed and computed in the same manner, less all previous payments made.

9.5 Approval for Payment

9.5.1 The Owner’s Representative will, within fifteen (15) days after receipt of the Contractor's Application for Payment, either approve Contractor’s Application for Payment for such amount as the Owner’s Representative determines is properly due, or notify the Contractor of the Owner’s Representative's reasons for withholding certification in whole or in part as provided in Section 9.6.

9.6 Decisions to Withhold Approval

9.6.1 The Owner’s Representative may decide not to certify payment and may withhold approval in whole or in part, to the extent reasonably necessary to protect the Owner. If the Owner’s Representative is unable to approve payment in the amount of the Application, the Owner’s Representative will notify the Contractor as provided in Paragraph 9.5.1. If the Contractor and Owner’s Representative cannot agree on a revised amount, the Owner’s Representative will promptly issue approval for payment for the amount for which the Owner’s Representative is able to determine is due Contractor. The Owner’s Representative may also decide not to approve payment or, because of subsequently discovered evidence or subsequent observations, may nullify the whole or a part of approval for payment previously issued, to such extent as may
be necessary in the Owner’s Representative opinion to protect the Owner from loss because of:

1. defective Work not remedied or damage to completed Work;
2. failure to supply sufficient skilled workers or suitable materials;
3. third party claims filed or reasonable evidence indicating probable filing of such claims;
4. failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment, Owner may, at its sole option issue joint checks to subcontractors who have presented evidence that it has not been paid in accordance with the Contract;
5. reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
6. damage to the Owner or another contractor;
7. reasonable evidence that the Work will not be completed within the Contract Time or an unsatisfactory rate of progress made by Contractor;
8. Contractor's failure to comply with applicable Laws;
9. Contractor’s or Subcontractor’s failure to comply with contract Prevailing Wage requirements; or
10. Contractor’s failure to carry out the Work in strict accordance with the Contract Documents.

9.6.2 When the above reasons for withholding approval are removed, approval will be made for amounts previously withheld.

9.7 Progress Payments
9.7.1 Based upon Applications for Payment submitted to the Owner by the Contractor and approvals issued by the Owner’s Representative, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

9.7.2 The period covered by each Application for Payment shall be one (1) calendar month.

9.7.3 The Owner shall make payment to Contractor for amounts due and approved by Owner’s Representative not later than thirty (30) days after the Owner approves a properly detailed Application for Payment which is in compliance with the Contract Documents. The Owner shall not have the obligation to process or pay such Application for Payment until it receives an Application for Payment satisfying such requirements.

9.7.4 Based on the Schedule of Values submitted by Contractor, Applications for Payment submitted by Contractor shall indicate the actual percentage of completion of each portion of Contractor's Work as of the end of the period covered by the Application for Payment.

9.7.5 The Contractor shall promptly pay each Subcontractor and Supplier, upon receipt of payment from the Owner, out of the amount paid to the Contractor on account of such Subcontractor's or supplier's portion of the Work, the amount to which said Subcontractor or supplier is entitled, reflecting percentages actually retained from payments to the Contractor on account of each Subcontractor's or supplier's portion of the Work, in full compliance with state statute. The Contractor shall, by appropriate agreement with each Subcontractor or supplier, require each Subcontractor or supplier to make payments to Sub-subcontractors in similar manner.

9.7.6 Neither the Owner nor Architect shall have an obligation to pay or to see to the payment of money to a Subcontractor of any tier nor a laborer or employee of Contractor except to the extent required by law. Retainage provided for by the Contract Documents are to be retained and held for the sole protection of Owner, and no other person, firm or corporation shall have any claim or right whatsoever thereto.

9.7.7 An approval for payment by Owner’s Representative, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

9.8 Failure of Payment
9.8.1 If the Owner is entitled to reimbursement or payment from the Contractor under or pursuant to the Contract Documents, such payment by Contractor shall be made promptly upon demand by the Owner. Notwithstanding anything contained in the Contract Documents to the contrary, if the Contractor fails to promptly make any payment due the Owner, or the Owner incurs any costs and expenses to cure any default of the Contractor or to correct defective Work, the Owner shall have an absolute right to offset such amount against the Contract Sum and may, in the Owner's sole discretion, elect either to: (1) deduct an amount equal to that to which the Owner is entitled from any payment then or thereafter due the Contractor from the Owner, or (2) issue a written notice to the Contractor reducing the Contract Sum by an amount equal to that to which the Owner is entitled.

9.9 Substantial Completion
9.9.1 Substantial Completion is the stage in the progress of the Work as defined in Paragraph 1.1.9 as certified by the Owner.

9.9.2 When the Contractor considers the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall notify the Owner and the Architect. The Owner’s Representative will make an inspection to determine whether the Work or designated
portion thereof is substantially complete. If the Owner’s Representative's inspection discloses any item which is not in accordance with the requirements of the Contract Documents, the Contractor shall complete or correct such item upon notification by the Owner’s Representative. The Contractor shall then submit a request for another inspection by the Owner’s Representative to determine Substantial Completion. When the Work or designated portion thereof is substantially complete, the Owner will issue a Certificate of Substantial Completion. Substantial Completion shall transfer from the Contractor to the Owner responsibilities for security, maintenance, heat, utilities, damage to the Work and insurance. In no event shall Contractor have more than thirty (30) days to complete all items on the Punch List and achieve Final Completion. Warranties required by the Contract Documents shall commence on the date of Substantial Completion or as agreed otherwise.

9.9.3 At the date of Substantial Completion, the Contractor may apply for, and if approved by Owner’s Representative, the Owner, subject to the provisions herein, shall increase total payments to one hundred percent (100%) of the Contract Sum less one hundred fifty percent (150%) of the value of any incomplete Work and unsettled claims, as determined by the Owner’s Representative.

9.10 Partial Occupancy or Use
9.10.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, security, maintenance, heat, utilities, damage to the Work and insurance. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by the Owner’s Representative.

9.10.2 Immediately before such partial occupancy or use, the Owner, and Contractor shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work. Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

9.11 Final Completion and Final Payment
9.11.1 Upon receipt of written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Owner’s Representative and the Architect will promptly make such inspection and, when the Owner’s Representative and Architect find the Work acceptable under the Contract Documents and the Contract fully performed, the Owner’s Representative will promptly issue a final approval for payment; otherwise, Owner’s Representative will return Contractor's Final Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application. Submission of a Final Application for Payment shall constitute a further representation that conditions listed in Paragraph 9.11.2 as precedent to the Contractor's being entitled to final payment have been fulfilled. All warranties and guarantees required under or pursuant to the Contract Documents shall be assembled and delivered by the Contractor to the Owner’s Representative as part of the final Application for Payment. The final approval for payment will not be issued by the Owner’s Representative until all warranties and guarantees have been received and accepted by the Owner.

9.11.2 The Owner will request the Contractor to submit the application for final payment along with a manually signed notarized letter on the Contractor's letterhead certifying that:

.1 Labor costs, prevailing wage rates, fringe benefits and material costs have been paid.

.2 Subcontractors of any tier and manufacturers furnishing materials and labor for the project have fully completed their Work and have been paid in full.

.3 The project has been fully completed in accordance with the Contract Documents as modified by Change Orders.

.4 The acceptance by Contractor of its Final Payment, by check or electronic transfer, shall be and operate as a release of all claims of Contractor against Owner for all things done or furnished or relating to the Work and for every act or alleged neglect of Owner arising out of the Work.

9.11.3 Final Payment constituting the entire unpaid balance due shall be paid by the Owner to the Contractor within thirty (30) days after Owner's receipt of Contractor's Final Application for Payment which satisfies all the requirements of the Contract Documents and Owner’s receipt of all information and documents set forth in Section 9.11.

9.11.4 No payment under this Contract, including but not limited to final payment, shall constitute acceptance by Owner of any Work or act not in accordance with the requirements of the Contract Documents.

9.11.5 No recourse shall be had against any member of the Board of Curators, or officer thereof, for any payment under the Contract or any claim based thereon.

ARTICLE 10
PROTECTION OF PERSONS AND PROPERTY

GC/27
08/18
10.1 Safety Precautions and Programs

10.1.1 The Contractor shall at all times conduct operations under this Contract in a manner to avoid the risk of bodily harm to persons or risk of damage to any property. The Contractor shall promptly take precautions which are necessary and adequate against conditions created during the progress of the Contractor's activities hereunder which involve a risk of bodily harm to persons or a risk of damage to property. The Contractor shall continuously inspect Work, materials, and equipment to discover and determine any such conditions and shall be solely responsible for discovery, determination, and correction of any such conditions. The Contractor shall comply with applicable safety laws, standards, codes, and regulations in the jurisdiction where the Work is being performed, specifically, but without limiting the generality of the foregoing, with rules regulations, and standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970 and applicable amendments.

10.1.2 All contractors, subcontractors and workers on this project are subject to the Construction Safety Training provisions 292.675 RSMo.

10.1.3 In the event the Contractor encounters on the site, material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead, mercury, or other material known to be hazardous, which has not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner's Representative and the Architect in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of the Owner's Representative and Contractor if in fact the material is asbestos or polychlorinated biphenyl (PCB) and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos or polychlorinated biphenyl (PCB), or when it has been rendered harmless by written agreement of the Owner's Representative and the Contractor. “Rendered Harmless” shall mean that levels of such materials are less than any applicable exposure standards, including but limited to OSHA regulations.

10.2 Safety Of Persons And Property

10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide protection to prevent damage, injury, or loss to:

1. students, faculty, staff, the public, construction personnel, and other persons who may be affected thereby;

2. the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor's Subcontractors of any tier; and any other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

10.2.2 The Contractor shall give notices and comply with applicable laws, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss.

10.2.3 The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, including, but not limited to, posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent sites and utilities.

10.2.4 When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise the highest degree of care and carry on such activities under supervision of properly qualified personnel.

10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Article 10 caused in whole or in part by the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable, and for which the Contractor is responsible under Article 10, except damage or loss attributable solely to acts or omissions of Owner or the Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's other obligations stated elsewhere in the Contract.

10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents, and the maintaining, enforcing and supervising of safety precautions and programs. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner's Representative and Architect. The Contractor shall hold regularly scheduled safety meetings to instruct Contractor personnel on safety practices, accident avoidance and prevention, and the Project Safety Program. The Contractor shall furnish safety equipment, and enforce the use of such equipment by it's employees and it's subcontractors of any tier.

10.2.7 The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.
10.2.8 The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident shall be reported immediately by telephone or messenger to the Owner.

10.2.9 The Contractor shall promptly notify in writing to the Owner of any claims for injury or damage to personal property related to the work, either by or against the Contractor.

ARTICLE 11
INSURANCE & BONDS

11.1 Insurance
11.1.1 Contractor shall secure from the date of the Contract for Construction and maintain for such periods of time as set forth below, insurance of such types and in such amounts specified below, to protect Contractor, Owner and others against all hazards or risks of loss described below. The form of such insurance together with carriers thereof, in each case, shall be approved by Owner, but, regardless of such approval, it shall be the responsibility of Contractor to maintain the insurance coverages set forth herein.

11.1.2 The contractor shall not be allowed on the Owners property without proof of the insurance coverages set forth herein.

11.2 Commercial General Liability
11.2.1 Contractor shall secure and maintain from the date of the Contract and for a period of at least five (5) years from the date of Final Completion of the entire Work Commercial General Liability insurance (“CGL”) with a combined single limit of not less than $2,000,000 per occurrence, $5,000,000 general aggregate, $5,000,000 products and completed operations aggregate and $1,000,000 personal injury and advertising injury. General Aggregate should apply per project. An umbrella policy may be used to satisfy these limits. If the General Aggregate is not on a per project basis, the contractor shall provide an additional $2,000,000 general aggregate.

11.2.2 CGL insurance shall be written on a comprehensive form and shall cover claims and liability in connection with or resulting from the Contractor’s operations and activities under the Contract, for personal injuries, occupational sickness, disease, death or damage to property of others, including loss of use resulting therefrom, arising out of any operations or activities of the Contractor, its agents, or any Subcontractors of any tier or by anyone directly or indirectly employed by either of them.

11.2.3 CGL insurance shall include premises, operations, independent contractors, products-completed operations, personal injury and advertising injury and liability assumed under an insured contract (including the tort liability of another assumed in a business contract) coverages. In particular, and not by way of any limitation, the CGL insurance shall cover the Contractor’s indemnity obligations contained in the Contract Documents.

11.2.4 There shall be no endorsement or modification of the CGL policy limiting the scope of coverage for liability arising from blasting, explosion, collapse, or underground property damage.

11.2.5 “The Curators of the University of Missouri” shall be endorsed as an “additional insured” under the CGL policy. The additional insured status must be conveyed by using the ISO CG 2 10 (2004) edition or equivalent and the ISO CG 20 37 (2004) edition. The policy shall be endorsed to be primary coverage and any other insurance carried by the Owner shall be excess only and will not contribute with Contractors’ insurance. To confirm, the Endorsement should accompany the insurance certificate.

11.2.6 Contractor waives all rights against Owner and its agents, officers, representatives and employees for recovery of damages to the extent those damages are covered by the CGL policy required hereunder.

11.3 Licensed for Use Vehicle Liability
11.3.1 Contractor shall secure and maintain from the date of the Contract for Construction until the date of Final Completion of the entire Work, insurance, to be on comprehensive form, which shall protect Contractor against any and all claims for all injuries and all damage to property arising from the use of automobiles, trucks and motorized vehicles, in connection with the performance of Work under this Contract, and shall cover the operation on or off the site of the Work of all motor vehicles licensed for highway use whether they are owned, non-owned or hired. Such insurance shall include contractual liability coverage and shall provide coverage on the basis of the date of any accident. The liability limits under such policy shall not be less than $2,000,000 combined single limit for bodily injury and property damage per accident.

11.3.2 Contractor waives all rights against Owner and its agents, officers, directors and employees for recovery of damages to the extent such damages are covered by the automobile liability insurance required hereunder.

11.4 Workers’ Compensation Insurance
11.4.1 Contractor shall purchase and maintain workers’ compensation insurance and employers’ liability insurance...
which shall protect Contractor from claims for injury, sickness, disease or death of Contractor’s employees or statutory employees. The insurance policies required hereunder shall include an “all states” or “other states” endorsement. In case any Work is sublet, Contractor shall require any Subcontractor of any tier to provide the insurance coverages required under this Section 11.4.

11.4.2 Contractor’s workers’ compensation insurance coverage shall be in compliance with all applicable Laws, including the statutes of the State of Missouri. Contractor’s employers’ liability coverage limits shall not be less than $1,000,000 each accident for bodily injury by accident or $1,000,000 each employee for bodily injury by disease.

11.5 Liability Insurance General Requirements

11.5.1 All insurance coverages procured by Contractor shall be provided by agencies and insurance companies acceptable to and approved by Owner. Any insurance coverage shall be provided by insurance companies that are duly licensed to conduct business in the State of Missouri as an admitted carrier. The form and content of all insurance coverage provided by Contractor are subject to the approval of Owner. All required insurance coverages shall be obtained and paid for by Contractor. Any approval of the form, content or insurance company by Owner shall not relieve the Contractor from the obligation to provide the coverages required herein.

11.5.2 All insurance coverage procured by the Contractor shall be provided by insurance companies having policyholder ratings no lower than "A-" and financial ratings not lower than "XI" in the Best's Insurance Guide, latest edition in effect as of the date of the Contract, and subsequently in effect at the time of renewal of any policies required by the Contract Documents. Insurance coverages required hereunder shall not be subject to a deductible amount on a per-claim basis of more than $10,000.00 and shall not be subject to a per-occurrence deductible of more than $25,000.00. Insurance procured by Contractor covering the additional insureds shall be primary insurance and any insurance maintained by Owner shall be excess insurance.

11.5.3 All insurance required hereunder shall provide that the insurer’s cost of providing the insureds a defense and appeal, including attorneys’ fees, shall be supplementary and shall not be included as part of the policy limits but shall remain the insurer’s separate responsibility. Contractor shall cause its insurance carriers to waive all rights of subrogation, except for Workers’ Compensation, against the Owner and its officers, employees and agents.

11.5.4 The Contractor shall furnish the Owner with certificates, Additional Insured endorsements, policies, or binders which indicate the Contractor and/or the Owner and other Contractors (where required) are covered by the required insurance covering type, amount, class of operations covered, effective dates and dates of expiration of policies prior to commencement of the work. Contractor is required to maintain coverages as stated and required to notify the University of a Carrier Change or cancellation within 2 business days. The University reserves the right to request a copy of the policy. Contractor fails to provide, procure and deliver acceptable policies of insurance or satisfactory certificates or other evidence thereof, the Owner may obtain such insurance at the cost and expense of the Contractor without notice to the Contractor.

11.5.5 With respect to all insurance coverages required to remain in force and affect after final payment, Contractor shall provide Owner additional certificates, policies and binders evidencing continuation of such insurance coverages along with Contractor’s application for final payment and shall provide certificates, policies and binders thereafter as requested by Owner.

11.5.6 The maintenance in full current force and effect of such forms and amounts of insurance and bonds required by the Contract Documents shall be a condition precedent to Contractor’s exercise or enforcement of any rights under the Contract Documents.

11.5.7 Failure of Owner to demand certificates, policies and binders evidencing insurance coverages required by the Contract Documents, approval by Owner of such certificates, policies and binders or failure of Owner to identify a deficiency from evidence that is provided by Contractor shall not be construed as a waiver of Contractor’s obligations to maintain the insurance required by the Contract Documents.

11.5.8 The Owner shall have the right to terminate the Contract if Contractor fails to maintain the insurance required by the Contract Documents.

11.5.9 If Contractor fails to maintain the insurance required by the Contract Document, Owner shall have the right, but not the obligation, to purchase said insurance at Contractor’s expense. If Owner is damaged by Contractor’s failure to maintain the insurance required by the Contract Documents, Contractor shall bear all reasonable costs properly attributable to such failure.

11.5.10 By requiring the insurance set forth herein and in the Contract Documents, Owner does not represent or warrant that coverage and limits will necessarily be adequate to protect Contractor, and such coverages and limits shall not be deemed as a limitation on Contractor’s liability under the indemnities granted to Owner in the Contract Documents.
11.5.11 If Contractor’s liability policies do not contain a standard separation of insureds provision, such policies shall be endorsed to provide cross-liability coverage.

11.5.12 If a part of the Work hereunder is to be subcontracted, the Contractor shall: (1) cover any and all Subcontractors in its insurance policies; (2) require each Subcontractor to secure insurance which will protect said Subcontractor and supplier against all applicable hazards or risks of loss designated in accordance with Article 11 hereunder; and (3) require each Subcontractor or supplier to assist in every manner possible in the reporting and investigation of any accident, and upon request, to cooperate with any insurance carrier in the handling of any claim by securing and giving evidence and obtaining the attendance of witnesses as required by any claim or suit.

11.5.13 It is understood and agreed that the insurance coverages required by the provisions of this Article 11 are required in the public interest and that the Owner does not assume any liability for acts of Contractor or Subcontractors of any tier or their employees in the performance of the Contract or Work.

11.6 Builder’s Risk Insurance
11.6.1 The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the State of Missouri, as an admitted carrier, builder’s risk insurance on the entire Work. Such insurance shall be written on a completed value form for the entire Work. The insurance shall apply on a replacement cost basis.

11.6.2 The insurance as required herein shall name as insureds the Owner, Contractor and all Subcontractors of any tier. The insurance policy shall contain a provision that the insurance will not be canceled, allowed to expire or materially changed until at least thirty (30) days prior written notice has been given to Owner.

11.6.3 The insurance as required herein shall cover the entire Work, including reasonable compensation for Architect’s services and expenses made necessary by an insured loss. Insured property shall include portions of the Work located away from the site (including all offsite stored materials) but intended for use at the site, and shall also cover portions of the Work in transit, including ocean transit. The policy shall include as insured property scaffolding, falsework, and temporary buildings located at the site. The policy shall cover the cost of removing debris, including demolition as may be made legally necessary by the operation of any law, ordinance or regulation.

11.6.4 The insurance required herein shall be on an all risk form and shall be written to cover all risks of physical loss or damage to the insured party and shall insure at least against the perils of fire and extended coverage, theft, vandalism, malicious mischief, collapse, lightning, earthquake, flood, frost, water damage, windstorm and freezing.

11.6.5 If there are any deductibles applicable to the insurance required herein, Contractor shall pay any part of any loss not covered because of the operation of such deductibles.

11.6.6 The insurance as required herein shall be maintained in effect until the earliest of the following dates:

1. the date which all persons and organization who are insureds under the policy agree in writing that it shall be terminated;
2. the date on which final payment of this Contract has been made by Owner to Contractor; or
3. the date on which the insurable interests in the property of all insureds other than the Owner have ceased.

11.6.7 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors of any tier, suppliers, agents and employees, each of the other, (2) the Architect and Architect’s consultants, and (3) separate contractors described in Article 6, if any, and any of their subcontractors of any tier, suppliers, agents and employees, for damages caused by fire or other perils to the extent covered by property insurance obtained pursuant to this Section 11.7 or other insurance applicable to the Work, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require of the Architect, Architect’s consultants, separate contractors described in Article 6, if any, and the subcontractors of any tier, suppliers, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, was at fault or was negligent in causing the loss and whether or not the person or entity had an interest in the property damaged.

11.6.8 A loss insured under Contractor’s property insurance shall be adjusted by the Owner in good faith and made payable to the Owner for the insureds, subject to requirements of the Contract Documents. The Contractor shall pay Subcontractors of any tier their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors of any tier to make payments to their Sub-subcontractors in similar manner.

11.7 Bonds
11.7.1 When the Contract sum exceeds Fifty Thousand Dollars ($50,000), the Contractor shall procure and furnish a Performance Bond and a Payment Bond in the form prepared by the Owner, each in an amount equal to one hundred percent (100%) of the Contract Sum, as well as adjustments to the Contract Sum. The Performance Bond shall secure and guarantee Contractor’s faithful performance of this Contract, including but not limited to Contractor’s obligation to correct defects after final payment has been made as required by the Contract Documents. The Payment Bond shall secure and guarantee payment of all persons performing labor on the Project under this Contract and furnishing materials in connection with this Contract. These Bonds shall be in effect through the duration of the Contract plus the Guaranty Period as required by the Contract Documents.

11.7.2 The bonds required hereunder shall be executed by a responsible surety licensed in the State of Missouri, with a Best’s rating of no less than A-/XI. The Contractor shall require the attorney in fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of this power of attorney indicating the monetary limit of such power.

11.7.3 If the surety of any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to conduct business in the State of Missouri is terminated, or it ceases to meet the requirements of this paragraph, Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to Owner. If Contractor fails to make such substitution, Owner may procure such required bonds on behalf of Contractor at Contractor’s expense.

11.7.4 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds to such person or entity.

11.7.5 The Contractor shall keep the surety informed of the progress of the Work, and, where necessary, obtain the surety’s consent to or waiver of: (1) notice of changes in the Work; (2) request for reduction or release of retention; (3) request for final payment; and (4) any other material required by the surety. The Owner shall be notified by the Contractor, in writing, of all communications with the surety, as it relates to items one through four. The Owner may, in the Owner’s sole discretion, inform surety of the progress of the Work, any defects in the Work, or any defaults of Contractor under the Contract Documents and obtain consents as necessary to protect the Owner's rights, interest, privileges and benefits under and pursuant to any bond issued in connection with the Work.

11.7.6 Contractor shall indemnify and hold harmless the Owner and any agents, employees, representative or member of the Board of Curators from and against any claims, expenses, losses, costs, including reasonable attorneys’ fees, as a result of any failure of Contractor to procure the bonds required herein.

ARTICLE 12
UNCOVERING AND CORRECTION OF THE WORK

12.1 Uncovering of the Work
12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it shall, if required in writing by the Architect or the Owner's Representative, be uncovered for the Architect's observation and be replaced at the Contractor's expense without change in the Contract Time.

12.1.2 If a portion of the Work has been covered which the Architect or the Owner's Representative has not specifically requested to observe, prior to its being covered, the Architect or the Owner's Representative may request to see such Work, and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be charged to the Owner. If such Work is not in accordance with the Contract Documents, the Contractor shall pay such costs unless the condition was caused by the Owner or a separate contractor in which event the Owner will be responsible for payment of such costs.

12.2 Correction of the Work
12.2.1 The Architect or Owner’s Representative shall have the right to reject Work not in strict compliance with the requirements of the Contract Documents. The Contractor shall promptly correct Work rejected by the Architect or the Owner's Representative for failing to conform to the requirements of the Contract Documents, whether observed before or after final completion and whether or not fabricated, installed, or completed. If Work has been rejected by Architect or Owner’s Representative, the Architect or Owner’s Representative shall have the right to require the Contractor to remove it from the Project site and replace it with Work that strictly conforms to the requirements of the Contract Documents regardless if such removal and replacement results in “economic waste.” Contractor shall pay all claims, costs, losses and damages caused by or resulting from the correction, removal or replacement of defective Work, including but not limited to, all costs of repair or replacement of Work of others. The Contractor shall bear costs of correcting, removing and replacing such rejected Work, including additional testing and inspections and compensation for the Architect's services and expenses made necessary thereby. If prior to the date of final payment, the Contractor, a Subcontractor or anyone for whom either is responsible uses or damages any portion of
the Work, including, without limitation, mechanical, electrical, plumbing and other building systems, machinery, equipment or other mechanical device, the Contractor shall cause such item to be restored to “like new” condition at no expense to the Owner.

12.2.2 If, within twelve (12) months after the date of Final Completion of the Work or designated portion thereof, or after the date for commencement of warranties, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found not to be in strict accordance with the requirements of the Contract Documents, the Contractor shall correct or remove and replace such defective Work, at the Owner’s discretion. Such twelve (12) month period is referred to as the “Guarantee Period.” The obligations under this Paragraph 12.2.2 shall cover any repairs, removal and replacement to any part of the Work or other property caused by the defective Work.

12.2.3 The Contractor shall remove from the site portions of the Work which are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

12.2.4 If the Contractor fails to correct nonconforming Work within a reasonable time, the Owner may correct or remove it and replace such nonconforming Work. If the Contractor does not proceed with correction of such nonconforming Work within a reasonable time fixed by written notice from the Owner, the Owner may take action to correct or remove the nonconforming work at the contractor’s expense.

12.2.5 The Contractor shall bear the cost of correcting destroyed or damaged Work or property, whether completed or partially completed, of the Owner or of others caused by the Contractor’s correction or removal of Work which is not in accordance with the requirements of the Contract Documents.

12.2.6 Nothing contained in Article 12 shall be construed to establish a period of limitation with respect to other obligations that the Contractor might have under the Contract Documents. Establishment of the twelve (12) month Guarantee Period as described in Article 12 relates only to the specific obligation of the Contractor to correct, remove or replace the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations under the Contract Documents. The requirements of Article 12 are in addition to and not in limitation of any of the other requirements of the Contract for warranties or conformance of the Work to the requirements of the Contract Documents.

12.3 Acceptance of Nonconforming Work
12.3.1 The Owner may accept Work which is not in accordance with the Contract Documents, instead of requiring its removal and correction, in its sole discretion. In such case the Contract Sum will be adjusted as appropriate and equitable. Such adjustment shall be made whether or not final payment has been made. Nothing contained herein shall impose any obligation upon the Owner to accept nonconforming or defective Work.

ARTICLE 13
MISCELLANEOUS PROVISIONS

13.1 Written Notice
13.1.1 All notices required to be given by the contractor under the terms of this Contract shall be made in writing. Written notice when served by the Owner will be deemed to have been duly served if delivered in person to the individual or a member of the firm or entity or to an office of the corporation for which it was intended, or if delivered at or sent to the last business address known to the party giving notice.

13.2 Rights and Remedies
13.2.1 Duties and obligations imposed by the Contract Documents, and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

13.2.2 No action or failure to act by the Owner, the Architect, or the Owner’s Representative will constitute a waiver of a right or duty afforded to the Owner under the Contract Documents, nor will such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed in writing.

13.2.3 The terms of this Contract and all representations, indemnifications, warranties and guarantees made in, required by or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the Work and termination or completion of the Work and shall remain in effect so long as the Owner is entitled to protection of its rights under applicable law.

13.2.4 Contractor shall carry out the Work and adhere to the current construction schedule during all disputes or disagreements with the Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements except as the Owner and Contractor may otherwise agree to in writing.
13.3 Tests and Inspections
13.3.1 Tests, inspections, and approvals of portions of the Work required by the Contract Documents or by laws, ordinances, rules or regulations shall be made at an appropriate time. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing laboratory or entity acceptable to the Owner, and shall bear related costs of tests, inspections, and approvals. The Contractor shall give the Architect and the Owner's Representative timely notice of when and where tests and inspections are to be made so the Architect and/or the Owner's Representative may observe procedures.

13.3.2 If the Architect or the Owner's Representative determine that portions of the Work require additional testing, inspection or approval not included in the Contract Documents, or required by law, the Architect, or the Owner's Representative will instruct the Contractor to make arrangements for such additional testing, inspection, or approval by an entity acceptable to the Owner's Representative and the Contractor shall give timely notice to the Architect, and the Owner's Representative, of when and where tests and inspections are to be made so the Architect and/or the Owner's Representative may observe such procedures. The Owner will bear such costs except as provided elsewhere in Article 13.

13.3.3 If such procedures for testing, inspection, or approval under Article 13 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, the Contractor shall bear all costs made necessary by such failure including those of repeated procedures and compensation for the Architect's services and expenses.

13.3.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Owner’s Representative and Architect.

13.3.5 Contractor shall take all necessary actions to ensure that all tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

13.3.6 Contractor shall arrange for and pay for all costs of all testing required by the Contract Documents or any applicable Laws for materials to be tested or certified at or on the place or premises of the source of the material to be supplied. The Owner shall have the right to require testing of all materials at the place of the source of the material to be supplied if not required by the Contract Documents or any applicable Laws. The Owner shall bear the costs of such tests and inspections not required by the Contract Documents or by applicable Laws unless prior defective Work provides Architect or Owner with a reasonable belief that additional defective Work may be found, in which case Contractor shall be responsible for all costs of tests and inspections ordered by the Owner or Architect, whether or not such tests or inspection reveals that Work is in compliance with the Contract Documents.

13.4 Nondiscrimination in Employment Equal Opportunity
13.4.1 The University serves from time to time as a contractor for the United States government. Accordingly, the provider of goods and/or services shall comply with federal laws, rules and regulations applicable to subcontractors of government contracts including those relating to equal employment opportunity and affirmative action in the employment of minorities (Executive Order 11246), women (Executive Order 11375), persons with disabilities (29 USC 706) and Executive Order 11758, and certain veterans (38 USC 4212 formerly [2012]) contracting with business concerns with small disadvantaged business concerns (Publication L. 95-507). Contract clauses required by the Government in such circumstances are incorporated herein by reference.

13.5 Supplier Diversity Goal Program
13.5.1 The Contractor shall subcontract with diverse firms no less than the amount pledged in the Contractor’s Bid and/or the amount accepted by the Owner.

13.5.2 If the Contractor must remove any diverse subcontractor of any tier, the Contractor shall replace the diverse subcontractor of any tier with another diverse subcontractor(s) of equal dollar value to the diverse supplier removed. The Contractor shall immediately notify the Owner’s Representative in writing of the Contractor’s intent to remove any, and the Contractor’s plan to maintain subcontracts with diverse firms of no less than amount pledged in the Contractor’s Bid and/or the amount accepted by the Owner. All changes of diverse subcontractor of any tier shall be approved by the Director of Facilities Planning & Development.

13.5.3 If the Contractor fails to meet or maintain the contractor’s Supplier Diversity subcontracting pledge, the Contractor shall immediately notify in writing the Owner’s Representative, and the Director of Facilities Planning & Development. Such notice shall include a description of the Contractor’s good faith effort to comply with their Supplier Diversity subcontracting pledge.

13.5.4 If the Director of Facilities Planning & Development finds the Contractor has failed to comply in good faith with the Owner’s Supplier Diversity goal program, the Director may take appropriate action, including but not limited to, declaring the Contractor ineligible to participate in any contracts with the Owner for a period not to exceed six (6) months, and/or directing that the Contractor's actions be
declared a material breach of the Contract and that the Contract be terminated.

13.5.5 The Contractor and his subcontractors shall develop, implement, maintain, and submit in writing to the Director of Facilities Planning & Development, an affirmative action program if at least fifty (50) persons in the aggregate are employed under this contract. If less than fifty (50) persons in the aggregate are to be employed under this contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed "Affidavit for Affirmative Action" in the form as included in the Contract Documents. For the purpose of this section, an "Affirmative Action Program" means positive actions to influence all employment practices (including, but not limited to, recruiting, hiring, promoting, and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between 40 and 70), disabled and Vietnam-era veteran status, and handicapped otherwise qualified status. Such affirmative action program shall include:

1. A written policy statement committing the total organization to affirmative action and assigning management responsibilities and procedures for evaluation and dissemination.

2. The identification of a person designated to handle affirmative action.

3. The establishment of non-discriminatory selection standards, objective measures to analyze recruitment, an upward mobility system, a wage and salary structure, and standards applicable to lay-off, recall, discharge, demotion, and discipline.

4. The exclusion of discrimination from collective bargaining agreements.

5. Performance of an internal audit of the reporting system to monitor execution and to provide for future planning.

13.5.6 In the enforcement of this non-discrimination requirement, the Owner may use any reasonable procedures available, including but not limited to: requests, reports, site visits, and inspection of relevant documents of Contractors and Subcontractors of any tier. The contractor shall submit a final Affidavit of Supplier Diversity Participation for each diverse firm at the end of the project stating the actual amount paid to the diverse firm.

13.6 Wage Rates (If the contract amount is less than $75,000, the requirements of this section will not apply. Any contract adjustments that increase the contract above $75,000 will be subject to this section.)

13.6.1 The Contractor shall pay workers employed in the execution of this contract in full each week and not less than the predetermined wage rates and overtime for work of a similar character that have been made a part of this Contract. These rates are determined by the University of Missouri Director of Facilities Planning and Development. The rates are based on wage rates published in the Annual Wage Orders of the Missouri Department of Labor and Industrial Relations (MDLIR). The Contractor is to use MDLIR 8 CSR 30-3.020; .030; .040, .060 in determining the appropriate occupational titles and rates for workers used in the execution of this contract. All determinations and/or interpretations regarding wage rates and classification of workers will be made by the office of the University of Missouri Director of Facilities Planning and Development. The Contractor is responsible for the payment of the aggregate of the Basic Hourly Rate and the Total Fringe Benefits to the workers on the project. Fringe benefit payments may be made to the worker in cash, or irrevocably made by a Contractor or Subcontractor to a trustee or to a third person pursuant to a fund, plan or program, or pursuant to an enforceable commitment, or any combination thereof, to carry out a financially responsible plan or program which was communicated in writing to the workmen affected, for medical or hospital care, pensions on retirement or death, compensation for injuries or illness resulting from occupational activity, or insurance to provide any of the foregoing, for unemployment benefits, life insurance, disability and sickness insurance, accident insurance, for vacation and holiday pay, for defraying costs of apprenticeship or other similar programs, or for other bona fide fringe benefits, but only where the Contractor or Subcontractor is not required by other federal or state law to provide any of the benefits as referenced in §290.210(5) RMSO 1994. Pay for travel, mileage, meals, bonuses, or other expenses are not fringe benefits and cannot be considered part of the workers wage rate. The Contractor shall not make any deductions for food, sleeping accommodations, transportation, use of small tools, uniforms, or anything of any kind or description, unless the Contractor and employee enter into an agreement in writing at the beginning of the worker’s term of employment, and such agreement is approved by the Owner. In the event the contract contains more than one wage determination the Contractor shall comply with both.

13.6.2 The Contractor shall submit to the Owner with the Contractor’s periodic pay request, certified payroll records for labor performed by the Contractor and Subcontractors of any tier. The Contractor shall submit all required certified payroll information records electronically in pdf format using the Owner’s web-based payment program. The certified payroll forms shall contain the name, address, personal identification number, and occupational title of the workers as well as the hours they work each day. The Owner’s acceptance of certified payroll records does not in any way relieve the Contractor of any responsibility for the payment of prevailing wages to workers on the project. The Contractor shall also maintain copies of the certified payroll
13.6.3 The acquisition of products or services is subject to the supplier's conformance to the rules and regulations of the President's Committee on Equal Employment Opportunity (41 CFR, Ch. 60).

13.6.4 The Contractor shall comply with the Copeland Regulations of the Secretary of Labor (29 CFR, Part 3), which are incorporated herein by reference. In addition, the Weekly Statement of Compliance required by these Regulations shall also contain a statement that the applicable fringe benefits paid are equal to or greater than those set forth in the minimum wage decision.

13.6.5 Contractor acknowledges that violation of the requirements of Article 13.6 result in additional costs to Owner, including, but not limited to, cost of construction delays, of additional work for Owner’s staff and legal expense. The cost of Contractor’s violation of the provisions of Article 13.6 would be and is difficult to determine and establish. In the event that Contractor fails to comply with the provisions of this Article 13.6, Owner shall be entitled to retain or recover from the Contractor, as liquidated damages and not as a penalty, the sum of Fifty Dollars ($50.00) per day per individual who is paid less than the applicable prevailing wage, to approximate the investigative cost resulting to the Owner for such violations. To approximate the delay costs, Owner shall be entitled to retain or recover from the Contractor, as liquidated damages and not as a penalty, the sum of One Hundred Dollars ($100.00) per day for each day the Contract cannot be closed out and final payment made because of Contractor’s failure to comply with the provisions of this Article 13.6. Such liquidated damages shall be collected regardless of whether the Work has been completed. The liquidated damages and other amounts set forth in this Article 13.6 shall be in addition to all other liquidated damages the Owner may be entitled as set forth in the Contract Documents.

13.6.6 The Owner may deduct liquidated damages described Article 13 and the amounts set forth in Article 13 from any unpaid amounts then or thereafter due the Contractor under the Contract. Any liquidated damages not so deducted from any unpaid amounts due the Contractor shall be payable to the Owner at the demand of the Owner.

13.6.7 The Contractor shall specifically incorporate the obligations of Article 13 into the subcontracts, supply agreements and purchase orders for the Work and require the same of any Subcontractors of any tier.

13.6.8 Contractor acknowledges and recognizes that a material factor in its selection by the Owner is the Contractor’s willingness to undertake and comply with the requirements of this Article 13.6. If Contractor fails to comply with the provisions of this Article 13.6, Owner may, in its sole discretion, immediately terminate the Contract upon written notice. The rights and remedies of Owner provided herein shall not be exclusive and are in addition to other rights and remedies provided by law or under this Contract.

13.6.9 Only such workers who are individually registered in a bona fide apprenticeship program approved by the U.S. Department of Labor, Office of Apprenticeship can be paid less than the journeyperson rate of pay. “Entry Level Workers; must be registered apprentices. The apprenticeship ratio will be one to one with a journeyperson of the same classification. Any worker not registered as an apprentice per this section will be paid as a journeyperson.

13.6.10 The Contractor shall post the wage rates for the contract in a conspicuous place at the field office on the project. On projects where there is no field office the Contractor may post the wage rates at their local office, as long as they provide a copy of the wage rates to a worker upon request. The wage rates shall be kept in a clearly legible condition for the duration of the project.

13.6.11 Neither the Contractor, nor any Subcontractor of any tier, nor any person hired by them or acting on their behalf, shall request or demand that workers pay back, return, donate, contribute or give any part, or all, of said workers wages, salary, or any thing of value, upon the statement, representation or understanding that failure to comply with such request or demand will prevent such worker from procuring or retaining employment. The exception being to an agent or representative of a duly constituted labor organization acting in the collection of dues or assessments of such organization.
13.6.12 No contractor or subcontractor may directly or indirectly receive a wage subsidy, bid supplement, or rebate for employment on this project if such wage subsidy, bid supplement, or rebate has the effect of reducing the wage rate paid by the employer on a given occupational title below the prevailing wage rate as provided in contract. In the event a wage subsidy, bid supplement, or rebate is provided or received, the entity receiving such subsidy, supplement, or rebate shall report the date and amount of such subsidy, supplement, or rebate to the University within thirty days of receipt of payment. This disclosure report shall be a matter of public record. Any employer not in compliance with this Article shall owe to the University double the dollar amount per hour that the wage subsidy, bid supplement, or rebate has reduced the wage rate paid by the employer below the prevailing wage rate for each hour that work was performed.

13.6.13 Time and one half overtime will be paid on all hours over 10 hours per day or 40 hours per week. The wage rate is the total of the “Basic Hourly Rate” plus “Total Fringe Benefits” or the “public works contracting minimum wage”. For all work performed on a Sunday or Holiday, not less than twice the prevailing hourly rate of pay or public works contracting minimum wage will apply. Holidays are as follows: January first, the last Monday in May, July fourth, the first Monday in September, November 11, the fourth Thursday in November, December twenty-fifth. If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

13.7 Records

13.7.1 The Owner, or any parties it deems necessary, shall have access to and the right to examine any accounting or other records of the Contractor involving transactions and Work related to this Contract for five (5) years after final payment or five (5) years after the final resolution of any on going disputes at the time of final payment. All records shall be maintained in accordance with generally accepted accounting procedures, consistently applied. Subcontractors of any tier shall be required by Contractor to maintain records and to permit audits as required of Contractor herein.

13.8 Codes and Standards

13.8.1 The Work shall be performed to comply with the International Code Council (ICC) Codes, and the codes and standards noted below. The latest editions and supplements of these Codes and Standards in effect on the date of the execution of the Contract for Construction shall be applicable unless otherwise designated in the Contract Documents. Codes and standards required by accreditation agencies will also be used unless the ICC requirements are more stringent. In the event that special design features and/or construction systems are not covered in the ICC codes, the applicable edition of the National Fire Protection Association (NFPA) family of standards and/or the NFPA 101 Life Safety Code shall be used.

.1 ICC International Building Code and reference standards
.2 ICC International Plumbing Code
.3 ICC International Mechanical Code
.4 NFPA 70 National Electric Code (NEC)
.5 Americans with Disabilities Act – Standards for Accessible Design.
.6 American National Standard Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks as published by the American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI) A17.1
.7 NFPA 101 Life Safety Code (as noted above)
.8 American Concrete Institute (ACI)
.9 American National Standards Institute (ANSI)
.10 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
.11 American Refrigeration Institute (ARI)
.12 American Society for Testing and Materials (ASTM)
.13 Missouri Standard Specification for Highway Construction, Missouri State Highway Commission
.14 National Electrical Manufacturers Association (NEMA)
.15 Underwriter's Laboratories, Inc. (UL), Federal Specifications
.16 Williams Steiger Occupational Safety and Health Act of 1970 (OSHA)

13.9 General Provisions

13.9.1 Any specific requirement in this Contract that the responsibilities or obligations of the Contractor also apply to a Subcontractor is added for emphasis and are also hereby deemed to include a Subcontractor of any tier. The omission of a reference to a Subcontractor in connection with any of the Contractor's responsibilities or obligations shall not be construed to diminish, abrogate or limit any responsibilities or obligations of a Subcontractor of any tier under the Contract Documents or the applicable subcontract.

13.9.2 This Contract shall be interpreted, construed, enforced and regulated under and by the laws of the State of Missouri. Whenever possible, each provision of this Contract shall be interpreted in a manner as to be effective and valid under applicable law. If, however, any provision of this Contract, or a portion thereof, is prohibited by law or found invalid under any law, only such provision or portion thereof shall be ineffective, without invalidating or affecting the remaining provisions of this Contract or valid portions of such provision, which are hereby deemed severable. Contractor and Owner further agree that in the event any provision of this Contract, or a portion thereof, is prohibited by law or found
invalid under any law, this Contract shall be reformed to replace such prohibited or invalid provision or portion thereof with a valid and enforceable provision which comes as close as possible to expressing the intention of the prohibited or invalid provision.

13.9.3 Contractor and Owner each agree that the State of Missouri Circuit Court for the County where the Project is located shall have exclusive jurisdiction to resolve all Claims and any issue and disputes between Contractor and Owner. Contractor agrees that it shall not file any petition, complaint, lawsuit or legal proceeding against Owner in any other court other than the State of Missouri Circuit Court for the County where the Project is located.

13.9.4 Owner’s total liability to Contractor and anyone claiming by, through, or under Contractor for any Claim, cost, loss, expense or damage caused in part by the fault of Owner and in part by the fault of Contractor or any other entity or individual shall not exceed the percentage share that Owner’s fault bears to the total fault of Owner, Contractor and all other entities and individuals as determined on the basis of comparative fault principles.

13.9.5 Contractor agrees that Owner shall not be liable to Contractor for any special, indirect, incidental, or consequential damage whatsoever, whether caused by Owner’s negligence, fault, errors or omissions, strict liability, breach of contract, breach of warranty or other cause or causes whatsoever. Such special, indirect, incidental or consequential damages include, but are not limited to loss of profits, loss of savings or revenue, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar types of damages.

13.9.6 Nothing contained in this Contract or the Contract Documents shall create any contractual relationship with or cause of action in favor of a third party against the Owner.

13.9.7 No member or officer of the Board of Curators of the University incurs or assumes any individual or personal liability under the Contract or by reason of the default of the Owner in the performance of any terms thereof. Contractor releases and discharges all members or officers of the Board of Curators of the University from any liability as a condition of and as consideration for the award of the Contract to Contractor.

13.9.8 The Contractor hereby binds itself, its partners, successors, assigns and legal representatives to the Owner in respect to covenants, agreements and obligations contained in the Contract Documents. Contractor shall not assign the Contract or proceeds hereof without written consent of the Owner. If Contractor attempts to make such an assignment without such consent, it shall be void and confer no rights on third parties, and Contractor shall nevertheless remain legally responsible for all obligations under the Contract. The Owner’s consent to any assignment is conditioned upon Contractor entering into a written assignment which contains the following language: “it is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor and to claims and to liens for services rendered or materials supplied for the performance of the Work required in said Contract in favor of all persons, firms, corporations rendering such services or supplying such materials.”

13.10 Debarment and Suspension Certification
The contractor certifies to the best of its knowledge and belief that it and its principals are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency in accordance with Executive Order 12549 (2/18/86).

ARTICLE 14
TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 Termination by Owner for Cause
14.1.1 In addition to other rights and remedies granted to Owner under the Contract Documents and by law, the Owner may terminate the Contract if the Contractor:
.1 refuses or fails to supply enough properly skilled workers, superintendents, foremen, or managers;
.2 refuses or fails to supply sufficient or proper materials;
.3 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;
.4 disregards laws, ordinances, rules, or regulations or orders of a public authority having jurisdiction;
.5 disregards the authority of the Owner’s Representative or Architect;
.6 breaches any warranty or representations made by the Contractor under or pursuant to the Contract Documents;
.7 fails to furnish the Owner with assurances satisfactory to the Owner evidencing the Contractor's ability to complete the Work in compliance with all the requirements of the Contract Documents;
.8 fails after commencement of the Work to proceed continuously with the construction and completion of the Work for more than ten (10) days, except as permitted under the Contract Documents;
.9 fails to maintain a satisfactory rate of progress with the Work or fails to comply with approved progress schedules; or
.10 violates in any substantial way any provisions of the Contract Documents.

14.1.2 When any of the above reasons exist, the Owner may, without prejudice to any other rights or remedies of the Owner,
terminate this Contract by delivering a written notice of termination to Contractor and Contractor’s surety, and may:

1. take possession of the site and all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
2. accept assignment of subcontracts pursuant to Paragraph 5.3; and
3. finish the Work by whatever reasonable method the Owner may deem expedient, including turning the Work over to the surety.

14.1.3 The Contractor, in the event of a termination under Section 14.1, shall not be entitled to receive any further payments under the Contract until the Work is completed in its entirety. Then, if the unpaid balance under the Contract shall exceed all expenses of the Owner in finishing the Work, including additional compensation for the Architects services and expenses made necessary thereby, such excess will be paid to the Contractor; but, if such expenses of Owner to finish the Work shall exceed the unpaid balance, the Contractor and its surety shall be liable for, and shall pay the difference and any damages to the Owner. The obligation of the Contractor and its surety for payment of said amounts shall survive termination of the Contract.

14.1.4 In exercising the Owner's right to secure completion of the Work under any of the provisions hereof, the Owner shall have the right to exercise the Owner's sole discretion as to the manner, methods, and reasonableness of costs of completing the Work.

14.1.5 The rights of the Owner to terminate pursuant to Article 14.1 will be cumulative and not exclusive and shall be in addition to any other remedy provided by law or the Contract Documents.

14.1.6 Should the Contractor fail to achieve Final Completion of the Work within thirty (30) calendar days following the date of Substantial Completion, the Owner may exercise its rights under Article 14.1.

14.2 Suspension by the Owner for Convenience

14.2.1 The Owner may, without cause, order the Contractor in writing to suspend, delay, or interrupt the Work in whole or in part for such period of time as the Owner may determine.

14.2.2 An adjustment will be made to the Contract Sum for increases in the cost of performance of the Contract caused by suspension, delay or interruption. However, in the event of a suspension under this Article 14.2, Contractor hereby waives and forfeits any claims for payment of any special, indirect, incidental or consequential damages such as lost profits, loss of savings or revenue, loss of anticipated profits, idle labor or equipment, home office overhead, and similar type damages. No adjustment will be made to the extent:

1. that performance is, was, or would have been so suspended, delayed or interrupted by another cause for which the Contractor in whole or in part is responsible, or
2. that an equitable adjustment is made or denied under another provision of this Contract.

14.3 Owner's Termination for Convenience

14.3.1 The Owner may, at any time, terminate the Contract in whole or in part for the Owner's convenience and without cause. Termination by the Owner under this Paragraph shall be by a notice of termination delivered to the Contractor specifying the extent of termination and the effective date.

14.3.2 Upon receipt of a notice of termination for convenience, the Contractor shall immediately, in accordance with instructions from the Owner, proceed with performance of the following duties regardless of delay in determining or adjusting amounts due under this Paragraph:

1. cease operation as specified in the notice;
2. place no further orders and enter into no further subcontracts for materials, labor, services or facilities except as necessary to complete Work not terminated;
3. terminate all subcontracts and orders to the extent they relate to the Work terminated;
4. proceed to complete the performance of Work not terminated; and
5. take actions that may be necessary, or that the Owner may direct, for the protection and preservation of the terminated Work.

14.3.3 Upon such termination, the Contractor shall recover as its sole remedy payment for Work properly performed in connection with the terminated portion of the Work prior to the effective date of termination and for items properly and timely fabricated off the Project site, delivered and stored in accordance with the Owner's instructions and for all Owner approved claims, costs, losses and damages incurred in settlement of terminated contracts with Subcontractors and suppliers. The Contractor hereby waives and forfeits all other claims for payment and damages, including, without limitation, anticipated profits, consequential damages and other economic losses.

14.3.4 The Owner shall be credited for (1) payments previously made to the Contractor for the terminated portion of the Work, (2) claims which the Owner has against the Contractor under the Contract and (3) the value of the materials, supplies, equipment or other items that are to be disposed of by the Contractor that are part of the Contract Sum.

14.3.5 Upon determination by a court that termination of Contractor or its successor in interest pursuant to Paragraph 14.1 was wrongful, such termination will be deemed converted
to a termination for convenience pursuant to Paragraph 14.3, and Contractor's sole and exclusive remedy for wrongful termination is limited to recovery of the payments permitted for termination for convenience as set forth in Paragraph 14.3.
SECTION 1.E
SPECIAL CONDITIONS

1. DEFINITIONS
"Drawings"

Drawings referred to in and accompanying Project Manual consist of Drawings prepared by and bearing name of below defined Architect, bearing December 19, 2019 WOMEN’S AND CHILDREN’S HOSPITAL - REPLACE AHU 4 & 11.

a. Architect
CORE 10 Architecture
4501 Lindell Blvd., Suite 1A
Saint Louis MO, 63108
(314) 726-4858

b. Mechanical & Electrical Engineer
IMEG Corporation
15 Sunnen Dr., Suite 104
Maplewood, MO
(314) 645 1132
(314) 645-1173 (fax)

c. Structural Engineer
IMEG Corporation
15 Sunnen Dr., Suite 104
Maplewood, MO
(314) 645 1132
(314) 645-1173 (fax)


2. SPECIAL SCHEDULING REQUIREMENTS
a. Special scheduling requirements supplemental to the bid form.
b. Site access and material delivery must be coordinated with Exterior Envelope Replacement project, CP180131.
c. AHU-4
(1) Contractor shall perform all work in the designated areas between August 17, 2020 and November 23, 2020, must be coordinated with the exterior envelope replacement CP180131, and approved by Owner’s Representative.
(2) Kitchen will be shut down for a maximum of 10 days to allow for the base bid scope to be completed.
(3) If the alternates are accepted as a part of this project the kitchen shall shutdown for a maximum of 21 days for all work to be completed.
(4) Excessive noisy work will need to be completed after hours or coordinated with Owner’s Representative.
(5) Contractor may begin on-site mobilization prior to approval of shop drawings and materials procurement.

SC - 1
d. AHU-11
   (1) Work shall be phased as indicated on drawings.
   (2) Excessive noisy work will need to be completed after hours or coordinated with Owner’s Representative.
   (3) Contractor shall coordinate all work within the Emergency Department and Sleep Study area with the Owner’s Representative.
   (4) Contractor may begin on-site mobilization prior to approval of shop drawings and materials procurement.

e. General Scheduling
   (1) Normal working hours are defined as weekdays between the hours of 7:00 am to 7:00 pm.
   (2) Night hours are defined as after 7:00 p.m. and before 7:00 a.m. Noisy work must stop between the hours of 7:00 p.m. and 7:00 a.m.
   (3) Weekend hours are defined as after 7:00 p.m. on Friday until 7:00 a.m. Monday. Noisy work must stop between the hours of 7:00 a.m. and 7:00 p.m.

f. Crane Work – All crane work associated with this project must be scheduled. This scheduling shall be coordinated and approved at least Fourteen (14) calendar days in advance with Owner’s Representative so that sufficient notification can be made to Owner’s personnel. Crane work for AHU-11 that is occurring at the front of the building shall occur on Saturdays and Sundays only. See the drawings for location of crane.

g. HVAC Testing and Balancing Provision – Contractor shall coordinate schedule with TAB Consultant prior to substantial completion and confirm with Owner’s Representative.

h. Utility Shut-Downs, Outages, and Tie-ins – Contractor shall submit a Utility Request for Outage Form including a written plan outlining the required shut-downs, outages, and tie-ins Fourteen (14) calendar days prior to starting the work.

i. Contractor shall implement a “Fire Watch” during, at a minimum, the following conditions:
   (1) Fire Alarm System out of service for more than four (4) hours in a 24-hour period.
   (2) Fire Sprinkler system out of service for more than ten (10) hours in a 24-hour period.
   (3) Fire Pump out of service for more than ten (10) hours in a 24-hour period.
   (4) Where utilized, fire watches (personnel) shall be provided with not less than one approved means for notification of the fire department and their only duty shall be to perform constant patrols of the protected premises and keep watch for fire.
   (5) A log shall be maintained identifying personnel performing fire watch duties and time period(s) assigned to the individual(s).

j. Refuse/Trash Removal and Material Delivery: Contractor can use elevator 5 and 6 between the hours of 5:30 a.m. and 7:30 a.m. or as directed by Owner’s Representative. The Owner has the right to request the Contractor provide vinyl wall protection (at Contractor’s expense) on the elevator walls if damage is occurring.

k. Project sequence and inter-project dependencies must be maintained in successful bidder’s schedule. Schedule development shall include, but not limited to, MU work activities of TAB, CERNER, IT, Hospital Engineering Support, and
Inspections and Testing.

l. Prior to any work in the contract area, provide isolation dampers to isolate construction area from general building air. Dampers are to remain where installed permanently. Contractor to coordinate with MU representatives on exact details of isolation method and scheduling. Airflow from the building systems will not be allowed during construction. Work to isolate is to be done during off-hours for disconnecting and reconnecting ductwork at the isolation dampers.

m. During the construction period all heating ventilation & air conditioning air distribution system components including but not limited to the air handler, supply & return duct, variable volume devices and dampers shall be protected from environmental contaminants including but not limited to dust, debris and fungi during transportation, installation and project activities prior to system start-up.

n. Contractor to provide and install MERV (8) filters over all SA, RA, EA grills to protect the air distribution system from contaminants throughout final TAB process until Terminal Clean.

o. Prior to start-up of the HVAC equipment/system, including but not limited to, make-up air units, air handling units, supply, return, and exhaust duct for any purpose, the construction project area shall be complete of all dirty work activities. The entire work area in which the system serves shall be thoroughly cleaned by the contractor and approved by MUHC Infection Control, per the definition of “Thorough Clean” in the Infection Control Cleaning Definitions. See “Special Conditions” and “Healthcare Construction Guidelines”.

3. SCOPE OF WORK

a. The Contractor shall furnish all labor, materials, tools, equipment necessary for, and incidental to, construction of this project as indicated on Drawings and specified herein.

b. Work shall include everything requisite and necessary to finish work properly, notwithstanding that every item of labor or materials or accessories required to make project complete may not be specifically mentioned.

c. General Description of Work:

(1) Project consists of the installation of two air handling units and 12 terminal air boxes.

(2) Demolition shall consist of the removal of two air handling units, roof penetrations, wall penetrations and removal of the ceiling in the kitchen.

(3) Architectural work shall consist of a fire rated enclosure around an existing piece of elevator equipment, moving a louver in the external wall and the repair or replacement of the kitchen ceiling.

(4) Structural work shall consist of platforms for air handling units on the roof.

(5) Mechanical work shall consist of replacement of two air handling units and installation of multiple terminal air boxes.

(6) Electrical work shall consist of providing power to the air handling units, VFD installation and new lighting.

4. LOCATION

a. Work shall be performed under this Contract on campus of the University of Missouri - Columbia, at Women’s and Children’s Hospital in Columbia MO.

5. NUMBER OF CONSTRUCTION DOCUMENTS

a. The Owner's Representative will furnish the Contractor a copy of executed Contract and a complete set of Drawings and Specifications in pdf format.

b. The Owner will furnish explanatory and changed Drawings in pdf format to
Contractor as issued during project.

c. Hard copy prints of any documents (bid or explanatory) will be printed at the Contractor’s expense through a printer of their choosing.

6. SUBMITTALS

a. The Contractor shall submit for approval to the Architect, equipment lists and Shop Drawings, as expeditiously as possible. Failure of the Contractor to submit Shop Drawings in a timely manner will result in the Owner holding back Contractor payments. (See General Conditions)

b. The material and equipment lists shall be submitted and approved before any material or equipment is purchased and shall be corrected to as-built conditions before the completion of the project.

c. The Contractor shall submit electronic versions of all required Shop Drawings, material and equipment lists. The Contractor shall upload all Shop Drawings to a secure information sharing website determined by the Owner notifying the Owner and Consultant that these shop drawings are available for review. Refer to: https://projex4.cf.missouri.edu/projex/#!home for protocols for the use of this website. Each submittal shall have the General Contractors digital stamp affixed to the first page signifying their review and acceptance. Review comments, approvals, and rejections will be posted on this same site with notification to the contractor. Submittals requiring a professional seal shall be submitted hard copy with a manual seal affixed.

(1) The Contractor shall identify each submittal item with the following:

(a) Project Title and Location
(b) Project Number
(c) Supplier’s Name
(d) Manufacturer’s Name
(e) Contract Specification Section and Article Number
(f) Contract Drawing Number
(g) Acrobat file name: Spec Section, Times Submitted-Spec Title: 033000 _01-Cast In Place Concrete.pdf

(2) Reference the accompanying Shop Drawing and Submittal Log at the end of this section (1.E.3) for required submittal information.

d. The Contractor shall submit to the Architect one (1) bound copy, one pdf copy and a thumb drive or CD consisting of all required Operating Instructions and Service Manuals for the Architect’s and the Owner’s sole use prior to completing 50% of the adjusted contract. Payments beyond 50% of the contract amount may be withheld until all Operating Instructions and Service Manuals are received as referenced in the accompanying Operating Instructions and Service Manual Log at the end of this section (1.E.4).

e. The Contractor shall submit to the Owner’s Representative all items referenced in the accompanying Closeout Log (1.E.5) within 30 days following substantial completion of the work. The Owner’s Representative will maintain the closeout log and include as an agenda item at all coordination meetings.

7. NOTIFICATION

a. Before beginning Demolition Work or service outages, the Contractor shall provide, at minimum, seventy-two (72) hours advance notice to Owner’s Representative for purpose of verifying utility locations including, but not limited to, gas, telecommunications, electric, water, steam, sewer, and nitrogen. Contractor shall minimize the number of outages, minimize the length of outages and related
work shall be continuous until the utility is restored.

8. USE OF PREMISES

a. Access: Access to construction site shall be as indicated on Drawings and as directed by the Owner's Representative. (EMERGENCY DEPARTMENT, ROOFS, SLEEP STUDY AREA)

(1) Parking at Women’s and Children’s Hospital: parking and staging is only allowed in the contractors parking and staging lot, located at the corner of Lansing and Portland streets.

b. Storage of materials: Storage of material is only allowed in the contractors parking and staging lot, located at the corner of Lansing and Portland streets.

c. Utilities: Drinking water, water required to carry on work, and 120 volt electrical power required for small tool operation may be obtained without cost to the Contractor from existing utilities at locations designated by the Owner's Representative. Provisions for obtaining power, including temporary extensions, shall be furnished and maintained by the Contractor. Upon completion of work such extensions shall be removed and any damage caused by use of such extensions shall be repaired to satisfaction of the Owner's Representative, at no cost to the Owner.

d. Restroom: Existing toilet facilities within Project Limits or Restrooms designated by the Owner's Representative for use by the Contractor will be available. Failure of the Contractor to maintain restrooms in a clean condition will be cause for the Contractor's discontinued use of the restroom.

e. The use of tobacco products is prohibited at the University of Missouri and all properties owned, operated, leased or controlled by the University of Missouri. Violation of the policy is defined as the use of any tobacco products, including e-cigarettes.

f. Landfill: The Contractor shall not use the Owner’s landfill. Dumping or disposal of excavated or demolition materials on Owner’s property shall not be permitted. The Contractor shall remove and legally dispose of excavated or demolished materials off the Owner’s property.

g. Care of Project Work Site: The contractor shall be responsible for maintaining the construction site in a reasonably neat and orderly condition by regular cleaning and mowing of the premises as determined by the Owner’s Representative.

h. Discharge to Sewer Request: The University of Missouri’s MS4 permit and NPDES Storm Water Discharge Permits along with the City of Columbia’s POTW Operating Permit as well as local ordinances, and state and federal environmental regulations prohibit hazardous materials from being disposed into either the storm water or sanitary sewer systems. Unless specifically approved, all chemical products such as paints, dyes, lawn care products, maintenance products, and oil is are prohibited from drain disposal. Any product, including contaminated water, being discarded into the storm water or sanitary sewer systems requires written approval from the Owner through a formal “Discharge to Sewer Request” form obtained at Discharge to Sewer Request Form. The contractor should submit the form to the Owner’s Representative, not to the Department of Environmental Health and Safety as the form indicates.

i. All concrete waste material including washout water shall be totally contained and removed from the Owner’s property.

j. Artifacts Found During Construction: Contractor shall immediately notify the Owner’s Representative when artifacts are uncovered or found during the
demolition or construction process. Artifacts include, but are not limited to, tools, drawings (construction or other), photographs, books and other objects/devices which may hold historical importance/significance. Do not remove or disturb the object(s) in question. Artifacts are not considered part of demolished materials and shall remain the property of the University of Missouri.

9. PROTECTION OF OWNER’S PROPERTY
   a. Contractor shall be responsible for repair of damage to building exterior and interior, drives, curbs, streets, walks, grass, shrubbery and trees, which was caused by workmen or equipment employed during progress of work. All such repairs shall be made to satisfaction of the Owner's Representative, at no cost to the Owner, or reimburse the Owner if the Owner elects to make repairs. For landscape damage, the Owner shall make such repairs. Compensation for these repairs shall be determined by the Owner's Representative using the "Valuation of Landscape Trees, Shrubs, and other Plants" as published by the International Society of Arboriculture, as last revised.

10. SUBSTITUTIONS and EQUALS
    a. Substitutions are defined in General Conditions article 3.11.8 for and Equals are defined General Conditions Article 3.12.
    b. Substitutions and/or Equals of the item(s) listed below will be allowed only prior to receipt of bids provided that a written request for approval has been received by both the Architect and the Owner at least ten calendar days prior to the date for receipt of Bids. All other substitution and/or Equals items shall follow the procedures set forth in the General Conditions.

    | Item | Specification Section |
    |------|-----------------------|
    | Lock Cylinders 7-pin (Best) | 08 7100 |
    | Control System – (WCH) Seimens | 23 0900 |
    | Fire Alarm System – (WCH) Notifier 2020 | 28 3100 |

    c. If the Architect and Owner approve a proposed substitution prior to receipt of Bids, such approval will be set forth in an Addendum. Bidders shall not rely upon approval made in any other manner.
    d. No substitutions and/or equal will be allowed for the following items:

11. PERMITS
    a. Permits and inspection for work on UM property are required.
    b. The owners Representative shall secure University Authority Having Jurisdiction building permits required for the project and shall provide a list of required inspection to the Contractor.
       (1) The Contractor shall coordinate and provide reasonable scheduling and access to the Work for the Owner’s Inspection.
       (2) Re-inspection of work as a result of either failed inspection or work not
ready as scheduled may be at the Contractor’s expense.

c. The Contractor shall comply with applicable codes and standards as listed in the Contract Documents, General Conditions, and the Healthcare Construction Guidelines.

d. All permits, including, but not limited to Infection Control, Hot Work, Fire Alarm, Energized Work and HVAC interruption shall be coordinated and scheduled with the Owner’s Representative or designee prior to commencement of the work.

e. Permits for Boilers, Water Heaters and Pressure Vessels require an installation permit from the State of Missouri. Before commencement of Boilers, Water Heaters or Pressure Vessels the Contractor must obtain an installation permit from the State of Missouri, Division of Fire Safety, Boiler and Pressure Unit as required by 11 CSR 40-2.010 through 11 CSR 40-2.065. The permit applications are available at http://www.dfs.dps.mo.gov/programs/bpv/.

12. SPECIALTIES
a. Roofing Protection Requirements: All construction staging to occur on existing roof areas, or for use as an access pathway to construction areas or facilitating removal of demolition materials, shall incorporate a minimum of two (2) layers of ¾” plywood protection on top of 1” polystyrene boards so as to not harm existing roof membrane or substrates, nor void any existing roof warranties. See Special Conditions Article 15, Roof Warranty Requirements.

13. PRE-BID INSPECTION
a. All pre-bid inspections of work areas shall be scheduled with pre-bid inspection guide, telephone: (573) 882 2228

14. MODIFICATIONS TO INFORMATION TO BIDDERS
a. Information to Bidders:
   (1) Referenced Information to Bidders, Page IFB/6. Add new Article 15.9.2 as follows:

   15.9.2.1 Within 48 hours of the receipt of bids, the apparent low bidder shall submit to the Director of Facilities Planning and Development an “Affidavit of Supplier Diversity Participation” for every diverse subcontractor or supplier the bidder intends to award work to on the contract. The affidavit will be signed by both the bidder and the diverse firm.

15. MODIFICATIONS TO GENERAL CONDITIONS
a. General Conditions:
   (1) The Commercial General Liability policy or policies specified in Article 11 shall provide coverage for special hazards, where they exist, such as, but not limited to, the operation of material hoist, blasting or other use of explosives, and damage to underground property.

16. PROJECT SCHEDULING
a. The project scheduling specification for the project are included immediately after the Special Conditions. For this project the Contractor shall meet the following scheduling requirements.

b. Contractor Schedule – Contractor is responsible for the schedule and he may provide with in-house personnel or hire a third party scheduling consultant. See Contractor Schedule Specification included in these documents.

17. PROJECT COORDINATION
a. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend
on each other for proper installation, connection, and operation.

(1) Schedule construction operations in the 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.

(2) Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.

(3) Make provisions to accommodate items scheduled for later installation.

18. BUILDING SYSTEM QUALITY ASSURANCE
   a. Contractor shall provide all personnel and equipment required to complete the quality assurance activities referenced in the Quality Assurance Plan. The requirements of the quality assurance plan shall be completed in their entirety before substantial completion and submitted as referenced in the Closeout Log.
   b. The contractor shall designate a competent person, separate from the superintendent or Project Manager, to act as the contractor’s quality assurance coordinator. The quality assurance coordinator is responsible for planning, scheduling, coordinating, conducting and verifying all quality assurance activities required by the quality assurance plan and ensuring all building systems are complete, operable and ready for use by the Owner. At a minimum, building ventilation systems, chilled/hot water generation systems, hydronic distribution systems, power distributions systems and fire detection and alarm systems, as applicable.

19. MECHANICAL, ELECTRICAL, PLUMBING (MEP) PRE-INSTALLATION MEETING(S)
   a. Before the start of MEP installation, the Owner’s Representative will convene an MEP pre-installation meeting. Meeting participants to include contractor (including MEP subcontractors), Owner’s Representative and additional contractor and University operational staff invited by the Owner’s Representative. Topics will include underground rough-ins, steam piping, chilled water piping, sprinkler piping, hot water piping, electrical system, duct, telephone/data wiring, control wiring.
   b. Additional meetings will be conducted as required for the review of coordination drawings and scope specific installations. Cross section drawings of corridor ceilings and other congested areas will be of highest priority and will be reviewed prior to the start of installations in the affected areas. Meeting minutes and sign-up sheet will be transcribed by contractor and distributed to attendees.

20. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS
   a. The Contractor shall be represented at the site by both a competent full-time Project Manager and a full-time, competent superintendent with no other assigned duties or responsibilities from the beginning of the work until its final acceptance, unless otherwise permitted by the Owner’s Representative. The superintendent for the Contractor for the general building work shall exercise general supervision over all subcontractors of any tier engaged on the work with decision-making authority of the Contractor.
   b. The Contractor shall use a current industry standard (Primavera, Microsoft Project, etc.) project scheduling software which provides as a minimum: Critical paths, milestones, estimated and actual start and completion dates, scheduled vs. actual progress, and detailed task and subtask breakdown. The following schedules shall be provided as a minimum and kept current: Overall project schedule, four- (4-) week look-ahead, and two- (2-) week look-ahead.
   c. The Contractor shall furnish on-site Internet access for use by his Project Manager.
and superintendent. The University is providing an on-line, secure project communications web site which will be used as a major method of communicating and storing project information. This web site will be used to communicate directed and group email, RFIs, change order requests and authorizations, and general correspondence. It will serve as a project message board, file storage and retrieval system, and will provide access to and storage of digital photos and contract documents and revisions.

21. WARRANTY WALKTHROUGH
   a. Contractor shall attend a walk-thru with the Owner at 11 months after acceptance to review and document any warranty items to be addressed as part of the 12 month warranty stated in article 3.1 of the General Conditions.

END OF SECTION
Contractor Schedule

1. GENERAL
   a) Time is of the essence for this contract. The time frames spelled out in this contract are essential to the success of this project. The University understands that effective schedule management, in accordance with the General Conditions and these Special Conditions is necessary to insure to that the critical milestone and end dates spelled out in the contract are achieved.
   
   b) Related Documents
   Drawings and general provisions of the Contract, including General Conditions’ Article 3.17 shall apply to this Section.
   c) Stakeholders
   A Stakeholder is anyone with a stake in the outcome of the Project, including the University, the University Department utilizing the facility, the Design Professionals, the Contractor and subcontractors.
   d) Weather
   (1) Contractor acknowledges that there will be days in which work cannot be completed due to the weather, and that a certain number of these lost days are to be expected under normal weather conditions in Missouri.
   (2) Rather than speculate as to what comprises “normal” weather at the location of the project, Contractor agrees that it will assume a total of 44 lost days due to weather over the course of a calendar year, and include same in its as planned schedule. For projects of less than a calendar year, lost weather days should be prorated for the months of construction in accordance with the following schedule.
   (3) Anticipated weather days for allocation/proration only. For projects lasting 12 months or longer, the 44 days per year plus whatever additional months are included will constitute normal weather.

<table>
<thead>
<tr>
<th>Jan – 5 days</th>
<th>Feb – 5 days</th>
<th>Mar – 4 days</th>
<th>Apr – 4 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>May – 3 days</td>
<td>Jun – 3 days</td>
<td>Jul – 2 days</td>
<td>Aug – 2 days</td>
</tr>
<tr>
<td>Sep – 3 days</td>
<td>Oct – 4 days</td>
<td>Nov – 4 days</td>
<td>Dec – 5 days</td>
</tr>
</tbody>
</table>

2. SCHEDULING PROCESS
   a) The intent of this section is to insure that a well-conceived plan, that addresses the milestone and completion dates spelled out in these documents, is developed with input from all stakeholders in the project. Input is limited to all reasonable requests that are consistent with the requirements of the contract documents, and do not prejudice the Contractor’s ability to perform its work consistent with the contract documents.
   Further, the plan must be documented in an understandable format that allows for each stakeholder in the project to understand the plan for the construction and/or renovation contained in the Project.
   b) Contractor Requirements
   (1) Schedule Development
   Contractor shall prepare the Project Schedule using Primavera P3 or Oracle P6.
   (2) Schedule Development
   Within 4 weeks of the NTP, contractor shall prepare a schedule, in CPM format, that reflects the contractor’s and each subcontractors plan for performing the contract work.
   Contractor shall review each major subcontractor’s schedule with the sub and obtain the subcontractor’s concurrence with the schedule, prior to submitting to the University.
   (3) Schedule Updates.
(a) Schedule Updates will be conducted once a month, at a minimum. Actual Start and Finish dates should be recorded regularly during the month. Percent Complete, or Remaining Duration shall be updated as of the data date, just prior to Contractor’s submittal of the update data.

(b) Contractor will copy the previous months schedule and will input update information into the new monthly update version.

(c) Contractor will meet with the Owner’s Representative to review the draft of the updated schedule. At this meeting, Owner’s Representative and Contractor will:
   (i) Review out of sequence progress, making adjustments as necessary,
   (ii) Add any fragments necessary to describe changes or other impacts to the project schedule and
   (iii) Review the resultant critical and near critical paths to determine any impact of the occurrences encountered over the last month.

(4) Schedule Narrative
   After finalization of the update, the Contractor will prepare a Narrative that describes progress for the month, impacts to the schedule and an assessment as to the Contractor’s entitlement to a time extension for occurrences beyond its control during the month and submit in accordance with this Section.

(5) Progress Meetings
   (a) Review the updated schedule at each monthly progress meeting. Payments to the Contractor may be suspended if the progress schedule is not adequately updated to reflect actual conditions.
   (b) Submit progress schedules to subcontractors to permit coordinating their progress schedules to the general construction work. Include 4 week look ahead schedules to allow subs to focus on critical upcoming work.

3. CRITICAL PATH METHOD (CPM)
   a) This Section includes administrative and procedural requirements for the critical path method (CPM) of scheduling and reporting progress of the Work.
   b) Refer to the General and Special Conditions and the Agreement for definitions and specific dates of Contract Time.
   c) Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the Project.
   d) Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.
   e) Network Diagram: A graphic diagram of a network schedule, showing the activities and activity relationships.
   f) 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.
   g) Critical activities are activities on the critical path.
   h) Predecessor activity is an activity that must be completed before a given activity can be started.
   i) Milestone: A key or critical point in time for reference or measurement.
   j) Float or Slack Time: The measure of leeway in activity performance. Accumulative float time is not for the exclusive use or benefit of the Owner or Contractor, but is a project resource available to both parties as needed to meet contract milestones and the completion date.
   k) Total float is herein defined as the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.
   l) Weather: Adverse weather that is normal for the area must be taken into account in the Contractor’s Project Schedule. See 1.d.3, above.
m) Force Majeure Event: Any event that delays the project but is beyond the control and/or contractual responsibility of either party.

n) Schedule shall including the following, in addition to Contractor’s work.
   (1) Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:
      (a) Requirements for phased completion and milestone dates.
      (b) Work by separate contractors.
      (c) Work by the Owner.
      (d) Coordination with existing construction.
      (e) Limitations of continued occupancies.
      (f) Uninterruptible services.
      (g) Partial occupancy prior to Substantial Completion.
      (h) Area Separations: Use Activity Codes to identify each major area of construction for each major portion of the Work. For the purposes of this Article, a "major area" is a story of construction, a separate building, or a similar significant construction element.

4. TIME EXTENSION REQUESTS
   a) Refer to General Conditions of the Contract for Construction, Article 4.7 Claims for Additional Time.
   b) Changes or Other Impacts to the Contractor’s Work Plan
      The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor’s updated schedule, in conjunction with the monthly application for payment. The Update must include:
      (1) An activity depicting the event(s) impacting the Contractors work plan shall be added to the CPM schedule, using the actual start date of the impact, along with actually required predecessors and successors.
      (2) After the addition of the impact activity(ies), the Contractor will identify subsequent activities on the critical path, with finish to start relationships that can be realistically adjusted to overlap using good, standard construction practice.
         (a) If the adjustments above result in the completion date being brought back within the contract time period, no adjustment will be made in the contract time.
         (b) If the adjustments above still result in a completion date beyond the contract completion date, the delay shall be deemed excusable and the contract completion date shall be extended by the number of days indicated by the analysis.
         (c) Contractor agrees to continue to utilize its best efforts to make up the time caused by the delays. However the Contractor is not expected to expend costs not contemplated in its contract, in making those efforts.

   c) Questions of compensability of any delays shall be held until the actual completion of the project. If the actual substantial completion date of the project based on excusable delays, excluding weather delays, exceeds the original contract completion date, AND there are no delays that are the responsibility of the contractor to consider, the delays days shall be considered compensable. The actual costs, if any, of the Contractor’s time sensitive jobsite supervision and general conditions costs, shall be quantified and a change order issued for these costs.
UNIVERSITY OF MISSOURI
ROOF SYSTEM MANUFACTURERS CERTIFICATION
(Revised 12/94)

TO: ________________________________ Title _____________________________
     Project No. ____________________
     Location ______________________

Our technical staff has examined the Architect/Engineer’s Drawings, Specifications and required warranty for the roofing work on this project. We do not wholly endorse the building design or any materials or services not part of our advertised roofing system.

CERTIFICATION

We hereby certify that:

1. All materials we will furnish and deliver to the project shall be of good merchantable quality, shall meet or exceed the Specifications required and shall, if properly applied by one of our approved roofing applicator firms in accord with our instructions, provide a sound weather/watertight roofing system.

2. Upon completion of the installation in accord with the Drawings and specifications and our recommended installation procedures, we shall issue a total system warranty specified in the project Specifications.

3. The Drawings and Specifications follow the recommendations of our roofing manual for this type of roofing system with:

   No exceptions.

The following exceptions: (The roofing system will be approved for this project if the following changes are made to the Contract Documents. The bid provided with this Document includes the required changes).

NOTE: Exceptions may cause Owner to reject bid.

Exceptions are as follows:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

4. The Warranty will be issued for the following proposed roofing system:

________________________________________________________________________

ROOFING SYSTEM MANUFACTURER: ____________________________________________

Authorized Signature: ________________________________________________________

Title: _______________________________ Date ________________________________

Telephone Number: (   )

Fax Number: (   )
WHEREAS (NAME AND ADDRESS OF COMPANY) herein referred to as Roofing Contractor, certify that they have furnished and installed all roofing, flashing, sheet metal and related components in accordance with the Contract Documents and as required by the Roofing System Manufacturer=s installation instructions on the facility described below:

Facility: __________________________________________________________

Owner: University of Missouri-(CAMPUS) (CAMPUS ADDRESS)

Date of Full Completion: ____________________

Approximate Area of Roof: ____________________

Type of Roofing Material: ____________________

Manufacturer’s Specification Number: __________

Thickness and Type of Roof Insulation: __________________________________________________________

NOW, THEREFORE, Roofing Contractor guaranties to the Owner, subject only to the exclusions stated hereinafter, that all roofing, flashing and sheetmetal work is fully and integrally watertight and is free from faults and defects in material or workmanship, and is guaranteed for a period of three (3) years from date of full completion of work.

EXCLUSIONS: This guarantee does not cover, and Roofing Contractor shall not be liable for the following:

1. Damage to the roofing system caused by fire, lightning, tornado, hurricane or hailstorm.

2. Damage to roofing system caused by significant settlement, distortion or failure of roof deck, walls, or foundations of building, excepting normal building expansion and contraction is not a part of this exclusion.

3. Abuse by the Owner and/or third parties.

REPAIRS: Owner shall promptly notify Roofing Contractor, in writing, of the need for repair of roofing, flashing, or sheet metal:

1. Roofing Contractor, within eight (8) hours after receipt of such notice, shall make emergency repairs at its expense, as required to render the facility watertight.

2. Within five (5) days after receipt of such notice, Roofing Contractor shall at its expense correct any faults or defects in material or workmanship.

3. Should needed repairs not be covered by this guarantee, Roofing Contractor, after having obtained Owner’s written consent, shall make such repairs at Owner’s expense. Following said repairs, this guarantee shall thereafter remain in effect for the unexpired portion of the original term. If Owner does not so consent or repairs are made by others than the Roofing Contractor, this guarantee shall terminate for those parts of the roof affected by the repair.

4. In the event that Owner has notified the Roofing Contractor of the need for repairs and (i) Roofing Contractor does not immediately make repairs, or (ii) Roofing Contractor disclaims responsibility for the repairs and Owner disagrees, or (iii) Owner considers Roofing Contractor=s quoted cost for repairs not covered by this guarantee to be unreasonable and, an emergency condition exists which requires prompt repair to avoid substantial damage or loss to Owner, then, Owner may make such temporary repairs as he finds necessary and such action shall not be a breach of the provisions of this guarantee.
ANNUAL INSPECTIONS: Roofing Contractor shall inspect roof installation prior to each of the three anniversary dates from date of full completion of the work.

1. Inspection team to include Roofing Contractor, Roof Manufacturer, and Owner=s Representative.

2. Inspection of total roof system will be included in the annual inspections.

3. All defects in total roof system will be corrected by the Roofing Contractor within 30 days of inspection.

4. Roof manufacturer will certify by a written report that roof inspection has been completed, defects are acknowledged, and will warrant any repairs.

5. All corrective work completed by Roofing Contractor shall be warranted as approved by the Roofing Manufacturer.

ROOF MODIFICATION: Should Owner require work to be done on roof of said facility including modifications, alternations, extensions or additions to roof and including installation of vents, platforms, equipment, bracings or fastenings, Owner shall notify Roofing Contractor and give Roofing Contractor an opportunity to make recommendations as to methods necessary to safeguard against damage to roofing covered by this guarantee. Failure of Owner to give Roofing Contractor such opportunity or failure to follow methods recommended by Roofing Contractor shall render this guarantee null and void to the extent such failure should result in damage to roofing covered by this guarantee.

NOTICES: Notification of Roofing Contractor by Owner, shall be fulfilled by sending notice to Roofing Contractor.

IN WITNESS WHEREOF, we set our hands this _____ day of __________, 20___.

By:__________________________________________________________

Title:_______________________________________________________

For Roofing Contractor

Name:_______________________________________________________

Address:____________________________________________________

Phone:_______________
**SHOP DRAWING AND SUBMITTAL LOG**

Project:  
Project Number:  
Contractor:  

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Contractor</th>
<th>Date Rec’d</th>
<th>#</th>
<th>Date Sent to Cons.</th>
<th>Date Ret’d</th>
<th>Remarks</th>
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<td>07 84 00</td>
<td>Schedule of Firestopping</td>
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<td>09 51 00</td>
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<td>21 05 29</td>
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<td>21 05 50</td>
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<td>21 05 53</td>
<td>Shop Drawings, Valve Chart</td>
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<td>21 13 00</td>
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<td>Shop Drawings, Pump Performance Curves</td>
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<td>Shop Drawings, Certifications</td>
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<td>23 74 13</td>
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<td>Shop Drawings, Product Data, CAD Floor Plans, Manufacturer Wiring Requirements, Installation and Maintenance Manuals, Manufacturers Certificate, NICET Certification, Battery Data,</td>
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### OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

**Project:**  
**Project Number:**  
**Contractor:**

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<th>Section</th>
<th>Description</th>
<th>Catalog Data</th>
<th>Wiring Diagrams</th>
<th>Installation Instructions</th>
<th>Service &amp; Maintenance Instructions</th>
<th>Parts List &amp; Availability</th>
<th>Performance Curves</th>
<th>Startup &amp; Operating Instructions</th>
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<tr>
<td>23 21 23</td>
<td>HVAC Pumps</td>
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<td>Power Ventilators</td>
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<td>26 28 16</td>
<td>Disconnect Switches</td>
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<td>Variable Frequency Drives</td>
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<td>28 31 00</td>
<td>Fire Alarm and Detection Systems</td>
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# CLOSEOUT LOG

**Project:**

**Project Number:**

**Contractor:**

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<th>Section</th>
<th>Description</th>
<th>Contractor/Subcontractor</th>
<th>Date Rec’ed</th>
<th># of Copies</th>
<th>CPM Initials</th>
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<td>GC/3.11</td>
<td>As-built drawings</td>
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<tr>
<td>SC/20</td>
<td>Executed commissioning plan w/ required documentation</td>
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<tr>
<td></td>
<td>List special warranties and guarantees for each section</td>
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<td></td>
<td>List any required maintenance stock, spare parts, etc.</td>
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<td>List any special tools, keys, etc.</td>
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<tr>
<td></td>
<td>Equipment List</td>
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<td></td>
<td>Power System Study Report</td>
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<td>Electronic model in SKM format using backup command</td>
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Sustainability Report

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Total weight of all demolition material: ____________

Percentage of total material diverted: ____________
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<tr>
<th>Commissioning Items by CSI Division</th>
<th>Verified by:</th>
<th>Date compl</th>
<th>Coord Initial</th>
<th>Documentation Required</th>
<th>Owner Witness Required</th>
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<tr>
<td><strong>1 Building System Commissioning</strong></td>
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<tr>
<td>Commissioning Agent - Conduct pre-installation meetings per specifications.</td>
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<td>Meeting Minutes</td>
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<td><strong>210503 Firestopping</strong></td>
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<tr>
<td>Do not enclose firestopping with other construction until inspection has been completed.</td>
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<td></td>
<td></td>
<td>Inspection Report</td>
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<tr>
<td><strong>211300 Fire Protection</strong></td>
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<tr>
<td>Flush, test and inspect stand piping per specifications</td>
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<td>test results report</td>
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<tr>
<td>Perform Systems Cleaning and Testing section of specifications</td>
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<td>NFPA 13 Certification</td>
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<td>Provide extra material as specified</td>
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<td>Transmittal</td>
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<td><strong>230503 Through Penetration Firestopping</strong></td>
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<tr>
<td>Do not enclose firestopping with other construction until inspection has been completed.</td>
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<td>Inspection Report</td>
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<td><strong>230553 Identification for HVAC Piping and Equipment</strong></td>
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<tr>
<td>Install pipe markers per specifications</td>
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<tr>
<td>Commissioning Items by CSI Division</td>
<td>Verified by:</td>
<td>Date compl</td>
<td>Coord Initial</td>
<td>Documentation Required</td>
<td>Owner Witness Required</td>
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<tr>
<td><strong>Testing, Adjusting, and Balancing</strong></td>
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<tr>
<td>230594</td>
<td>Coordinate and cooperate with owner's commissioning efforts</td>
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<tr>
<td></td>
<td>Coordinate temperature control testing and adjusting with temperature controls contractor</td>
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<tr>
<td></td>
<td>Mark equipment settings including central positions, value indicators, fan speed control levers, etc.</td>
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<tr>
<td></td>
<td>Notify Owner's Representative 14 days prior to the scheduled date for balancing the system.</td>
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<td>written notification</td>
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<tr>
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<td>Perform all activities as outlined in spec &quot;Description of Work&quot; and notify owner's rep that system is complete and ready for owner's TAB personnel.</td>
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<td>certification letter</td>
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<td><strong>Ductwork Insulation</strong></td>
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<td>230713</td>
<td>Verify all valves &amp; damper controls are extended and accessible</td>
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<td><strong>HVAC Piping Insulation</strong></td>
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<tr>
<td>230719</td>
<td>Verify all piping unions are accessible for maintenance</td>
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<tr>
<td><strong>Controls</strong></td>
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<td>230900</td>
<td>Calibrate/fine tune circuits &amp; equipment to achieve specified sequence of operation</td>
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<tr>
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<td>Check and record amp draw on supply transformers of I/O panels</td>
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<td>Test Report</td>
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<td>Ensure shipping material has been removed from thermostats and other control devices</td>
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<td>Check fan belt tension and fan rotation; if VFD, check rotation with and without drive</td>
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<td>Provide training as specified</td>
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<td>Verify that shipping blocks and bracing are removed</td>
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<td>Perform independent tests per &quot;Field Quality Control&quot; section of spec, including megohm/high pot tests</td>
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<td>Ensure identification devices are applied per specifications</td>
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<td><strong>260573</strong> Power System Study</td>
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<td>Factory certified technician to set electronic overcurrent devices to approved coordination study setpoints</td>
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<td>Test all devices per specifications.</td>
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<td>Test for continuity and short circuits prior to energization</td>
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<td><strong>262816</strong> Disconnect Switches</td>
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<td>Ensure Fuses are per manufacturing requirements</td>
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<td>Inspection Report</td>
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<tr>
<td>Start-up of VFD's shall be by factory rep. Perform all checks per manufacturer's written start-up checklist</td>
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<td>field report, certification</td>
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<td><strong>283100</strong> Fire Alarm and Detection Systems</td>
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12/5/2019
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<tr>
<td>Precheck system and fill out pretest checklist</td>
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<td>Provide factory training</td>
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<td>Test each system for continuity</td>
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<td>Test system operation of pull stations horns/strobes by factory trained representative</td>
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<td>Written certification of fire alarm system per NFP</td>
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12/5/2019
Please see following website for suggested commissioning forms:

https://www.cf.missouri.edu/cf/pdc/commissioning-forms
# Healthcare Construction Guideline
## SEPT 2017 Edition

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Section 1 Training Requirements
The purpose of the training requirements for contractors is to ensure that construction project work in and around the healthcare environment is managed in such a way to minimize health and safety risks associated with construction activities and that contractors know and understand their responsibilities.

Required Training
1. Contractor project managers, superintendents and subcontractor foremen will be required to attend the following training:
   • Minimum of One (1) hour training related to “Infection Control & Dust Barriers” and “Healthcare Construction Training for Contractors”.
2. Contractor project managers, superintendents and subcontractor foremen have the responsibility for ensuring that contractor employees are knowledgeable of the training requirements and direct their employees and project work accordingly.
3. Contractors will be required to utilize the MU Hospital online eMeditrack system for initiating work requests of various types, examples may include infection control barriers, utility outage, various permits required.
4. Contractors are required to report in and sign in and out at the designated location per building location each work day upon arrival and exit of the work location.

Training Agenda
At a minimum the topics to be covered in the training include the following:
2. Contractor Training Requirements.

Documentation
1. All employees who receive training will be required to sign their name on a training acknowledgement form stating that they have been oriented to the training requirements.
2. Healthcare Safety and Infection Control Requirements will be in the project contract documents for further review as required.
3. COMPLIANCE VIOLATIONS: Contractors/Vendors who violate the requirements of this Guideline are subject to disciplinary action and removal from the project.

Section 2 Emergency Phone Numbers & Contact Information
Telephone contacts should be used by the contractor for emergency situations which may arise during the construction project. Contact Plan will be identified and coordinated at the project Pre-Construction Meeting by the owner’s representative.

Section 3 Contractor Identification Badge
Contractors working in and around the MUHC facilities will be required to display and wear the “Contractor Identification Badge” and in accordance with the information displayed below. It is the responsibility of the contractor to provide the computer and color printer for reproduction of badges required. Consult the Owner’s Representative for the electronic file.

Contractor ID Badge
1. Contractor is to issue badges to employees as required. (Contractor to validate employee with proof of ID).
2. Contractor to edit the information, print in color, cut out the badges, fold in the center and insert. Contractor will provide badge holders.
3. Contractor shall keep a roster/log of badged employees by trade/subcontractor at the project jobsite for reference by the Owners Representative.
4. All badges to be collected and returned to PD&C at the end of the project.
5. Any orientation required will be discussed at the pre-construction meeting with the Owner’s Representative.
6. Contractor employees are to wear the badge on the upper chest facing forward unless approved otherwise for safety reasons.
7. All contractor superintendent and foreman shall attend “Healthcare Construction Training” and affix issued “T” sticker in the circle area on badge as shown. This will show evidence that the employee has completed training.
8. The Badge document will be provided to the Contractor to make copies and distribute as required. See Page HCG 12.

Section 4 General Safety Requirements for Health Care Projects
The General Contractor and its Subcontractors are responsible for understanding, planning and implementing the following requirements in the management of the project.
1. Make sure shoes/boots and clothing are free of excessive dirt/debris before entering and leaving the construction area.
2. If you leave any dust/dirt or tracks in the occupied area of the healthcare facility, you must stop and clean them up immediately by using a HEPA filtered vacuum and/or a clean dampened floor mop with a UMTH hospital approved furnished cleaning solution.
3. Assure that all construction material, supplies and tools are cleaned and covered with a clean covering material while transporting through the healthcare facility.
4. Ensure that the carts and wheels on tool and supply carts as well as trash/demolition waste carts are properly wiped clean before leaving the construction area. Cleaning/wiping solutions are provided by the hospital and must be approved per direction of the Owner’s Representative.
5. Staff and patients ALWAYS have priority and the “Right of Way” in the elevators and corridors.
6. Never use aerosol sprays or cleaning solvents that could dispense fumes, odors or cause potentially allergenic reactions or medical problems to susceptible patients, staff or visitors.

Section 5 Construction-Renovation-Maintenance Risk Assessment (CRMRA)
The “Construction-Renovation-Maintenance Risk Assessment” (CRMRA) planning process establishes criteria to be used and measures to be taken for the protection of patients, healthcare workers, visitors and contractors, from construction/renovation activities which could lead to infections or compromise existing life safety systems in the healthcare facility.

Once the Contractor is selected, they will be required, and the Subcontractors as applicable to participate in the “CRMRA” planning process for orientation of project requirements and help in identifying any additional project needs or risks prior to any contract construction work commencing.

The owner’s representative will work with the contractor to coordinate and facilitate these CRMRA planning activities with MUHC engineering services, infection control department and others as required during the duration of the project.

Section 6 Construction – Renovation – Maintenance Infection Control Risk Mitigation Criteria
The “Construction–Renovation-Maintenance Infection Control Risk Mitigation Criteria” (CRMICRMIC) is a process to evaluate construction projects for required interventions during construction in order to minimize Hospital Acquired Infections (HAI’s), and controlling dispersal of air and/or water-borne infectious agents concealed within the building components.
All construction activities shall be defined and managed in such a way that occupant’s exposure to dust, moisture and their accompanying hazards is limited.
1. Construction–Renovation-Maintenance Infection Control Risk Mitigation Criteria and the Construction–Renovation-Maintenance Infection Control Risk Mitigation Permit which will be used for all MUHC construction and renovation projects.
2. Any work required outside the main project limits will require a NEW Infection Control Risk Assessment.
3. The owner’s representatives and Contractor will work together to coordinate the assessment and determine the requirements and permit.
4. The owner’s representative will ensure that all required infection control interventions and needed life safety measures required for the project are in place by the contractor prior to starting work. (i.e. barrier walls, tacky mats, required exits, etc.)
5. The contractor shall follow all requirements to support the “Construction – Renovation- Maintenance Infection Control Risk Mitigation Criteria”.
6. The contract documents and CRM IC Permit will provide requirements specific to the project.
7. **Work outside of construction limits.** Prior to contractor performing any work outside of construction limits, the owner’s representative must be notified.

8. Contractors that violate the requirements of the “Construction – Renovation- Maintenance Infection Control Risk Mitigation Criteria/Permit” will be removed from the project.

**Section 7 Construction of Dust Barrier Walls**

Infection control is the number one health concern in a construction project. Infection can occur when workers are not cautious about keeping dust, bacteria, mold, etc. from becoming airborne during the construction process. For these reasons, barrier walls are built to isolate dust and fumes in the construction site to separate the patient care and public areas of the healthcare facility.

**Dust Barriers Walls and Contamination Reduction**

1. A signed copy of the “**CRM Infection Control Construction Permit**” shall be kept at the job site at all times. Large AND small projects may have several “**CRM Infection Control Construction Permits**” issued as project phases, needs and assessments evolve.

2. Barriers are required to contain the ceiling envelope, chases, interstitial spaces, etc.

3. When access and exiting to the construction site can only be accomplished through a public area, the interior space of the construction site must be cleaned once every 8 – hour shift to control excessive dust and ventilation filtering issues. Debris shall be removed daily.

4. A temporary fire resistant 6 mil., polyethylene dust barrier is required to control dust while the rigid barrier is being constructed as well as at the end of the job during removal of the rigid barrier.

5. Contractors are responsible to ensure that barrier systems and walls are properly constructed, penetrations sealed and maintained for effectiveness for the duration of the project. Anytime polyethylene is used in a control barrier, it must be fire resistant, 6 mil. See “**Approved Equipment and Product Information**”.

6. Once barrier walls are built they are required to be cleaned or wiped down prior to the start of work.

7. Barrier doors and exits from the construction site must be installed with a closer and kept in good working order with positive latching.

8. Keep doors closed except when in use in order to minimize migration of dust and to maintain negative air pressure relationships.

9. Doors must have a seal/door sweep installed at the undercut and weather stripping around the metal frame to control the migration of dust from the construction site.

10. Doors in barrier walls which are not in use by the contractor to the public spaces must be sealed off and taped around the door, frame and threshold undercut, in order to minimize migration of dust and to maintain negative air pressure requirements.

11. If an elevator, dumb waiter, pneumatic tube system, stairway, linen chute, or any other chased or open type building system is located within the construction site, a barrier wall system will be required to be built around the open building system from deck to deck and properly sealed at top, bottom and sidewalls.

12. **Upon completion of barriers and prior to beginning work,** the contractor shall notify the owner’s representative and healthcare construction compliance manager to coordinate an inspection and verify that the barrier wall meets requirements and that acceptable negative air pressure is being achieved.

**Special Notes:**

1. See “**Barrier Wall Design Details**” for additional requirements.

2. See section in this manual on “**Ventilation and Negative Air Pressure Requirements**” for additional requirements when building dust barrier systems and walls.

3. See section in this manual on “**Approved Equipment and Product Information**”.

**Section 8 Ventilation and Negative Air Pressure Requirements**

The first step is building of dust barrier walls to isolate the construction site from patient care and public areas of the healthcare facility to protect patients and the public from construction related dust, fumes and other activities. The effectiveness of barrier walls is minimal unless the construction site is also under negative air pressure. (i.e. air must flow from clean or public spaces into the dirty or construction site).

The following are the “**Ventilation and Negative Air Pressure Requirements**” which contractors shall strictly follow in the management and construction of their projects.

**Negative Air Pressure Requirements**

HCG - 4
1. The contractor shall provide all necessary **“Negative Air HEPA Filtered Ventilation Units”** required for the negative air requirements of the construction area.

2. See section in this manual on **“Approved Equipment and Product Information”** for more information.

3. The contractor will work with the owner’s representative to determine best methods and equipment set up requirements for the project.

4. The contractor shall run the **“Negative Air HEPA Filtered Ventilation Unit”** in the work zone location prior to starting any barrier wall construction or work.

5. **“Negative Air HEPA Filtered Ventilation Units”**, may be connected to normal or emergency power and shall run continuously, 24/7. Critical areas of the healthcare facility may require the HEPA filtered ventilation units to be connected to emergency power only.

6. A secondary method to maintain negative air pressure is by using the hospitals exhaust system attached to the **“Negative Air HEPA Filtered Ventilation Units”**. This process and installation must be approved by the owner’s representative.

7. **Pre-Filters shall be changed at least twice weekly during demolition and drywall sanding and a minimum of once a week during other times.** This frequency requirement may be relaxed for lower risk projects and on prior approval from the owner’s representative.

8. The contractor shall furnish and install the negative air-monitoring device to monitor daily negative air pressure -.01 inches of water column. See section in this manual on **“Approved Equipment and product Information”**.

9. The contractor shall record daily on the **“Negative Air Pressure and Filter Change Log”** the air pressure reading in the construction area to insure that appropriate negative air pressure is being maintained.

10. See **“Negative Air Pressure and Filter Change Log”** form at the end of this section.

**Barrier Walls and Negative Air Ventilation**

**Special Infection Control Requirements and Interventions for Contractors When Working In (Surgical OR’s, Sterile Processing, Bone Marrow Transplant)**

Construction activities can lead to increased Aspergillus counts in the air and increased risk for Aspergillus infections in high risk patients. In an effort to minimize and contain dust, and lessen the possibility of microbial contamination during renovation work in high risk special care units, Interventions are typically initiated and maintained until the completion of the project. The owner’s representative, MUHC infection control and engineering services departments will be involved in contractor orientation for project work procedures in high risk special care units.

Special work scheduling in these special care units may be a requirement of the project and contractor.
# Negative Air Pressure and Filter Change Log

**Project Name:** 

**Location:** 

Contractor to complete the **Negative Air Pressure and Filter Change Log** daily at the start of each work shift and maintain completed forms in the project safety file for future review. Post this log inside construction site entrance for use and review.

### Pressure Relationship Illustration

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Section 9 Interim Life Safety Measures Assessment (ILSM)

Interim Life Safety Measures (ILSM) are a series of administrative actions that must be taken to compensate temporarily for the hazards posed by existing NFPA Life Safety Code 101, 2014 edition deficiencies, other building code issues or construction activities. Examples of when construction activities require ILSM’s to be implemented are as follows:

1. Fire alarm system, detection, and/or sprinkler system are impaired or disabled.
2. Normal exits or exit routes and/or exit lighting have been compromised.
3. Re-routing of traffic due to construction activities.
4. Temporary narrowing of the corridor.
5. Deficiencies in fire and/or smoke separations and systems caused by construction activities. (Changes to wall, door, dampers, penetrations, etc.)
8. Hot work.

Whenever an “Interim Life Safety Measure” is identified for implementation during the construction project, there will typically be measures or actions required by both the MUHC engineering services department as well as the contractor. The contractor has the responsibility prior to the beginning of work and throughout the project to become familiar with the ILSM in order to plan and identify what construction related activities will require an evaluation of ILSM’s as noted in the ILSM. The “Interim Life Safety Measures Evaluation” is a required team effort.

Section 10 Noise and Vibration Control Management

Construction related noise and vibration control and mitigation measures are to be implemented when the contractor is working in and around healthcare facilities. The contractor shall work with the owner’s representative to develop means and methods for controlling excessive noise and vibration during construction.

Section 11 Above Ceiling Work Permit

All contractors who need access above ceilings in the public areas of the healthcare facility and outside the approved construction site shall be required to obtain an “Above Ceiling Work Permit” from the owner’s representative prior to disrupting or lifting out ceiling tiles. The contractor shall notify the owner’s representative fourteen (14) days prior to the need for ceiling access in order to process and evaluate any special requirements of the permit.

General Requirements for Working above Ceilings (“Above Ceiling Permit Required”)

1. The Construction-Renovation-Maintenance Infection Control Risk Mitigation Permit issued for the work activity will note specifics required for Barrier Types.
2. Any cable and wiring pulls through the healthcare facility which will require a ceiling disturbance must be approved in advance by obtaining an “Above Ceiling Work Permit”.
3. Ceiling tiles must not be left displaced by the contractor if he walks away from the area unless the area has been contained by an approved “Dust Barrier”.
4. If a ceiling tile is damaged by the contractor he should notify the owner’s representative to acquire a new tile for replacement.
5. All debris shall be cleaned up by the contractor daily when working in cabling and electrical closets.
6. Pulling of communication cables in a patient care or other critical care areas will require special scheduling. Consult with the owner’s representative for coordination.
7. When cables must be pulled in an active patient care unit, a dust partition must be used at the site of entry and exit of the cable.
8. The dust partition may be attached to the false ceiling because taking it to deck may interfere with the work.
9. The site of entry and exit of the cable or other above ceiling work must be HEPA vacuumed (ceiling tiles and pipes) before the work begins.
Section 12  Lock Out/Tag out Permit
The contractor shall give a minimum fourteen (14) working days notice to the owner’s representative for shutdown work on electrical systems or other critical utility systems which could significantly impact the healthcare facilities operations, the contractor will be required to plan these “Lock Out/Tag Out” activities ten (14) days in advance. Major utility shutdowns may require weeks of notice and planning. The contractor shall work with the owner’s representative to identify these time planning requirements.

Section 13  Utility Systems Shutdown & Service Permit
The “Utility Systems Shutdown & Service Permit” is to be used when work on an existing utility system may cause a disruption within the MUHC facility.

“Utility Systems” shall be defined as any system that would hinder the delivery of patient care and hospital operations should the system be interrupted for any reason. Planning for this work usually requires a contingency plan by the healthcare facility management department to address any failure of the utility system.

Utility Shutdown
Any and all utility or system connections, shut-off, or interruptions must be scheduled with the owner’s representative prior to commencement of the work. This work shall be defined as a “Utility Shutdown” and notice shall be made to the owner’s representative to coordinate the request and facilitation.

Utility Service - (System must be worked live or energized)
In addition to utility system connection, shut-off, or interruption, the contractor must also schedule any work on existing utility systems that either do not require interruption or cannot be interrupted to accomplish the work. This type of work shall be defined as “Utility Service” and notice shall be made to the owner’s representative.

The contractor shall give up to 14 working days’ notice to the owner’s representative in order to properly plan and coordinate required activities. All permits are to be posted at the job site location for the duration of the permit. When complete the contractor shall file the permits in the contractor job safety file for future review as may be required.

Section 14  Hot Work & Permit
Hot work shall be defined as welding, brazing, cutting soldering, grinding, or other activities which produce sparks or use flame which are capable of initiating fires or explosions.

All contractors performing construction, renovation and installation work for MUHC facilities are required to follow the requirements and provisions of NFPA 51B and the owner’s representative procedures related to “Hot Work” and obtaining a “Hot Work Permit”.

The following are the requirements for a contractor to obtain a “Hot Work Permit”.

1. Contractors shall contact the owner’s representative two (2) days, forty eight (48) hours in advance to request a hot work permit. A request for complex projects which requires extensive planning on behalf of the owner’s representative may require a longer notice period.
2. All hot work sites are inspected by the owner’s representative using the requirements printed on the “Hot Work Permit”.
3. The owner’s representative will issue a “Hot Work Permit” tag to be attached in the vicinity of the actual hot work being performed. Upon completion, the hot work tag shall be returned to the owner’s representative.
4. “Hot Work Permits” will be issued for only one shift unless other arrangements have been made with owner’s representative. All permits expire 30 minutes prior to the end of the shift.
5. If hot work cannot be completed within one work shift, the contractor is responsible for obtaining approval for a revised permit extension from the owner’s representative. The contractor is responsible for meeting all the safety requirements required by the permit for any and all extensions granted.
6. The contractor shall be responsible for supplying a trained worker for the requirement of a fire watch during the actual hot work. The fire watch’s only responsibility will be as a fire watch.
7. A fire watch shall be provided for 30 minutes following the completion of work, including during lunch and breaks by the contractor.

8. The contractor shall provide at a minimum a ten pound (10) ABC fire extinguisher that has a current, valid inspection tag.

9. A copy of the "Hot Work Permit" shall be kept in the general contractors project file for future review as may be required.

10. The contractor shall upload completed Hot Work Permits to the owner's electronic construction document program (Projex 4) in the Hot Work Permit folder for the project not less than on a weekly basis or as instructed by the owner's representative.

Section 15 Exterior Construction Site Helicopter Landings

Any contractor doing construction work or activities on the hospital grounds, property or on the roof of the buildings is required to follow the guidelines regarding construction activities during helicopter landings on the helipad. The contractor shall coordinate with the owner’s representative roof access, roof protection, keying, roof and safety precautions to be taken when working close to the roof edge regarding helicopter landings and contractor responsibilities during this time. In addition, the placement of vertical installations such as tall lighting poles and the use of project cranes or hoisting on the hospital property might affect the “Final Approach and Take Off” of medical center ambulance helicopters. It is essential that the contractor plans these types of activities with the owner’s representative prior to the beginning of work.
Section 16 Required Forms, Permits, Postings and Documentation

Note: Refer to the sections in the “Healthcare Construction Requirements” manual for detailed information on each form and permit approval procedure.

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<tr>
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The contractor will be required to furnish and install a “Project Safety Information” bulletin board on their project site for posting of required safety information. Small, short duration projects may have this requirement waived by the owner’s representative.

LEGEND  CRM = Construction-Renovation-Maintenance

Section 17 Project Cleaning and Barrier Removal Process

The following is the typical sequence prior to the removal of barrier walls.

With the barrier in place and with the “Negative Air HEPA Filtered Ventilation Unit” running, the contractor will HEPA vacuum all horizontal and vertical surfaces.

1. Clean the covers that are isolating the HVAC ducts.
2. Clean the outside of the negative air HEPA machine and its exhaust duct.
3. The contractor shall notify the owner’s representative to schedule a walk-through of the clean space for inspection and approval prior to removal of the barrier wall.
4. Following all job site cleaning and flushing of plumbing, the contractor can begin the barrier cleaning process.
5. During construction or removal of barrier walls, fire resistant polyethylene barriers must be put into place to help control any construction or demolition dust of the barrier wall system.

6. MUHC must approve removal of any Infection Control or other barriers. Prior to removal of the temporary fire resistant polyethylene barrier, it shall be vacuumed with a HEPA vacuum to eliminate any dust attached to the plastic. The polyethylene barrier is then wiped down with the use of damp cleaning cloths and using a hospital furnished approved infection control cleaning solution. The contractor shall roll or fold the polyethylene in on itself creating as little dust as possible prior to transporting out of the building in a covered cart.

7. Remove the covers or caps from any and all HVAC system supply, return and exhaust ducts and restore the HVAC system.

8. The “Negative Air HEPA Filtered Ventilation Unit” is removed from the project site once the HVAC system is verified is operating properly.

If Air Sampling Is Required
When construction/renovation is done and completed in or near a high risk assessment critical care unit (i.e. Burn Unit, Operating Rooms, Intensive Care, etc.) there may be a requirement to do air sampling after the negative air system has been removed and the building HVAC system has been restored. This will be a requirement only if the infection control department determines the need at the end of the project and prior to occupancy.

Section 18 Approved Equipment and Product Information

“NEGATIVE AIR HEPA FILTERED VENTILATION UNIT”, HEPA filter equipped negative air machines that provide rough in filters, primary filters and a HEPA final filter. Rating of 300 to 2000 cubic feet per minute, (CFM). HEPA filters must be a minimum 99.97% efficient @ 0.3 microns. Differential pressure alarm required if not installed in another fashion to monitor construction site negative air of – 0.01 water column. Or approved equal.

- MICRO Trap Corporation, Models MT 1000 or Model MT 2000.  1300 W. Steel Road, No. 2 Morrisville, PA 19067 (215) 295-8208 or (877) 646-8208.
- ABATEMENT Technologies, Inc. Model HEPA-AIRE PAS2400HC Portable Air Scrubber or Model PAS1200HC 605 Satellite Blvd. Suite 300 Suwanee, GA 30024 (800) 634-9091

“HEPA VACUUM”, A shop style vacuum with a HEPA filter cartridge at 99.97% filtration @ 0.3 microns. Or approved equal.

- ABATEMENT Technologies Inc. Model V1300H Hip Mounted HEPA Vacuum, designed for use on scaffolding and mobile conditions such as ceiling tile type cleaning. Lightweight at 6.4 lbs. 605 Satellite Blvd. Suite 300 Suwanee, GA 30024 (800) 634-9091.

“ADHESIVE WALK OFF MATS”, 24” x 36” Tacky Mat. Peel up dirty layer and dispose to reveal a new, fresh clean tacky mat.

- Tacky walk off mat No. 5838 24” x 36”, 60 tacky mats to a unit. Four units per case. 3M Company, St. Paul, MN 55144 (888) 364-3577. Or approved equal.

“NEGATIVE AIR PRESSURE INDICATOR”, Manometer.

- Model “Mark II Model No. 25 inclined-vertical Manometer. Dwyer Instruments Inc. PO Box 373, Michigan City, IN 46361 (219) 879-2000.
- MICRO Trap Corporation, Model Tri/Mon, digital recording manometer for tracking differential pressure. 1300 W. Steel Road, No. 2 Morrisville, PA 19067 (215) 295-8208 or (877) 646-8208.
“PORTABLE WORK ENCLOSURE”, For temporary fire resistant polyethylene dust barrier. System components supplier of zip poles, door opening access zippers, dust sealing system parts, etc.

- Zip Wall, LLC. 37 Broadway, Arlington, MA 02474  (800) 718-2255. Or approved equal.


Example of Badge for Contractor use -

Protocol for Hospital Contractor Badges:

Contractor to issue badges to employees as necessary. (Need to show proof of ID)

Contractor to edit the information, print in color, cut out the badges, fold in the center and insert in badge holders.

Contractor shall keep a log of badged employees on site for reference by MU as necessary.

All permits to be collected and returned to MU at the end of the project.

Any orientation required will be discussed at the preconstruction meeting with the Owner’s Representative.
SECTION 19  Health Care Construction Cleaning Definitions

Construction Clean
1. Remove tools & equipment from the work area.
2. Remove all bulk trash from the work area.
3. Thoroughly sweep all floor surfaces in the work area utilizing a dust compound (floor sweep) material.
4. Dry wipe all horizontal & vertical surfaces in the work area. Surfaces to include but not limited to walls, window sills, doors & door frames, base trim, casework (inside & out), fixtures, and wall-mounted equipment.
5. Sweep all floor surfaces utilizing a dust mop.
6. Wet mop all floor surfaces.

Thorough Clean
1. To be implemented only after Construction Clean procedures have been completed.
2. Wet wipe all horizontal and vertical surfaces utilizing a MUHC – Infection Control Department approved germicidal disinfectant. Surfaces to include but not limited to walls, window sills, doors & door frames, base trim, casework (inside & out), all fixtures, and wall-mounted equipment.
3. Wet mop all floor surfaces utilizing a MUHC Infection Control Department approved germicidal disinfectant.

Terminal Clean
1. To be implemented only after Thorough Clean procedures have been completed.
2. Cleaning procedures shall be conducted by MUHC trained Environmental Services, Sterile Processing or Surgical Services staff only.
3. Thoroughly clean and disinfect surfaces on the ceiling such as diffusers, light fixtures, and ceiling mounted devices & equipment.
4. Thoroughly clean and disinfect all equipment in the work area.
5. Thoroughly clean and disinfect all flooring including moving equipment & furnishings to allow access to all floor surfaces.
6. Move all portable equipment and furnishings away from the walls. Wet wipe and disinfect all wall surfaces and wall mounted equipment.
SECTION 1.F

INDEX OF DRAWINGS

Women’s and Children’s Hospital - Replace AHU 4 and 11
December 19, 2019

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Sheet 45 of 63  MP-103B.1  ROOF - MECHANICAL PIPING -AHU11 - PHASE 3
Sheet 46 of 63  MPD-103.3  ROOF - MECHANICAL PIPING DEMOLITION - AHU11 - PHASE 3
Sheet 47 of 63  MP-500  MECHANICAL PIPING DETAIL
Sheet 48 of 63  MP-600  MECHANICAL PIPING DIAGRAMS
Sheet 49 of 63  E-000  ELECTRICAL COVER SHEET
Sheet 50 of 63  ED-101A.2  LEVEL 01 - ELECTRICAL DEMOLITION - AHU4
Sheet 51 of 63  ED-102B.2  LEVEL 02 - ELECTRICAL DEMOLITION - AHU11 - PHASE 2
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Sheet 54 of 63  E-104A.1  ROOF - ELECTRICAL - AHU4
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Sheet 56 of 63  E-102B.3  LEVEL 02 - ELECTRICAL - AHU11 - PHASE 3
Sheet 57 of 63  E-103B.1  ROOF - ELECTRICAL -AHU11 - PHASE 1
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Sheet 61 of 63  E-500  ELECTRICAL DETAIL
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Sheet 63 of 63  E-601  ELECTRICAL SCHEDULE

END OF SECTION

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SECTION 1.G

PREVAILING WAGE RATES

Refer to the following attached Boone County Annual Wage Order No. 26.
Missouri
Division of Labor Standards
WAGE AND HOUR SECTION

MICHAEL L. PARSON, Governor

Annual Wage Order No. 26
Section 010
BOONE COUNTY

In accordance with Section 290.262 RSMo 2000, within thirty (30) days after a certified copy of this Annual Wage Order has been filed with the Secretary of State as indicated below, any person who may be affected by this Annual Wage Order may object by filing an objection in triplicate with the Labor and Industrial Relations Commission, P.O. Box 599, Jefferson City, MO 65102-0599. Such objections must set forth in writing the specific grounds of objection. Each objection shall certify that a copy has been furnished to the Division of Labor Standards, P.O. Box 449, Jefferson City, MO 65102-0449 pursuant to 8 CSR 20-5.010(1). A certified copy of the Annual Wage Order has been filed with the Secretary of State of Missouri.

Original Signed by
Taylor Burks, Director
Division of Labor Standards

Filed With Secretary of State: March 8, 2019

Last Date Objections May Be Filed: April 8, 2019

Prepared by Missouri Department of Labor and Industrial Relations
<table>
<thead>
<tr>
<th>OCCUPATIONAL TITLE</th>
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<td>Groundman</td>
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<td>Groundman - Tree Trimmer</td>
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<tr>
<td>Elevator Constructor</td>
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<td>Painter</td>
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<td>Roofer</td>
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<td>Group IV</td>
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</table>

*The Division of Labor Standards received less than 1,000 reportable hours as required by RSMo 290.257.4(b). Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center, in accordance with RSMo 290.257.2.

**Annual Incremental Increase

ANNUAL WAGE ORDER NO. 26

PW - 3
<table>
<thead>
<tr>
<th>OCCUPATIONAL TITLE</th>
<th>** Date of Increase</th>
<th>Basic Hourly Rates</th>
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<tbody>
<tr>
<td>Carpenter</td>
<td></td>
<td>$49.38</td>
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<tr>
<td>Group IV</td>
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</tr>
</tbody>
</table>

Use Heavy Construction Rates on Highway and Heavy construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(3).

Use Building Construction Rates on Building construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(2).

If a worker is performing work on a heavy construction project within an occupational title that is not listed on the Heavy Construction Rate Sheet, use the rate for that occupational title as shown on the Building Construction Rate Sheet.

*The Division of Labor Standards received less than 1,000 reportable hours as required by RSMo 290.257.4(b). Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center, in accordance with RSMo 290.257.2.

END OF SECTION
SECTION 1.H

ALTERNATES

Base Bid may be increased in accordance with following Additive Alternate proposal(s) as Owner may elect:

1. Additive Alternate NO. 1: Replacement of the hard ceiling within area A in the kitchen with a lay in ceiling. All Diffusers, Lights and Fire Protection heads within the area will be updated.
2. Additive Alternate NO. 2: Replacement of the hard ceiling within area B in the kitchen with a lay in ceiling. All Diffusers, Lights and Fire Protection heads within the area will be updated.

END OF SECTION
SECTION 01 91 00

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 COMMISSIONING DESCRIPTION

A. Various sections of the project specifications require equipment startup, testing, and adjusting services. Requirements for startup, testing, and adjusting services specified in the Division 23 and Division 26 series sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.

B. Where individual testing, adjusting, or related services are required in the project specifications and not specifically required by this commissioning requirements specification, the specified services shall be provided and copies of documentation, as required by those specifications shall be submitted to the University and the Commissioning Authority to be indexed for future reference.

C. Where training or educational services for University are required and specified in other sections of the specifications, including but not limited to Division 23 and Division 26 series sections of the specification, these services are intended to be provided in addition to the training and educational services specified herein.

D. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the University’s operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup, control system calibration, testing adjusting and balancing, performance testing and training. Commissioning during the construction and post-occupancy phases is intended to achieve the following specific objectives according to the contract documents:

1. Verify that the applicable equipment and systems are installed in accordance with the contact documents and according to the manufacturer’s recommendations.
2. Verify and document proper integrated performance of equipment and systems.
3. Verify that Operations & Maintenance documentation is complete.
4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
5. Verify that the University’s operating personnel are adequately trained to enable them to operate, monitor, adjust, maintain, and repair building systems in an effective and energy-efficient manner.

6. Document the successful achievement of the commissioning objectives listed above.

E. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.

1.2 CONTRACTUAL RELATIONSHIPS

A. For this construction project, the University of Missouri contracts with a Contractor to provide construction services.

B. In this project, only two contract parties are recognized and communications on contractual issues are strictly limited to University Project Managers (PM) and the Contractor. It is the practice of the University to require that communications between other parties to the contracts (Subcontractors and Vendors) be conducted through the PM and Contractor. It is also the practice of the University that communications between other parties of the project (Commissioning Authority and Architect/Engineer) be conducted through the PM.

C. Whole Building Commissioning is a process that relies upon frequent and direct communications, as well as collaboration between all parties to the construction process. By its nature, a high level of communication and cooperation between the Commissioning Authority and all other parties (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc.) is essential to the success of the Commissioning effort.

D. With these fundamental practices in mind, the commissioning process described herein has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Authority must develop effective methods to communicate with every member of the construction team involved in delivering commissioned systems while simultaneously respecting the exclusive contract authority of the Contracting Officer and PM. Thus, the procedures outlined in this specification must be executed within the following limitations:

1. No communications (verbal or written) from the Commissioning Authority shall be deemed to constitute direction that modifies the terms of any contract between the Department of Veterans Affairs and the Contractor.

2. Commissioning Issues identified by the Commissioning Authority will be delivered to the PM and copied to the designated Commissioning Representatives for the
Contractor and subcontractors on the Commissioning Team for information only in order to expedite the communication process. These issues must be understood as the professional opinion of the Commissioning Authority and as suggestions for resolution.

3. In the event that any Commissioning Issues and suggested resolutions are deemed by the PM to require either an official interpretation of the construction documents or require a modification of the contract documents, the Contracting Officer or PM will issue an official directive to this effect.

4. All parties to the Commissioning Process shall be individually responsible for alerting the PM of any issues that they deem to constitute a potential contract change prior to acting on these issues.

5. Authority for resolution or modification of design and construction issues rests solely with the Contracting Officer or PM, with appropriate technical guidance from the Architect/Engineer and/or Commissioning Authority.

1.3 RELATED WORK
   A. COMMISSIONING OF HVAC SYSTEMS.
   B. COMMISSIONING OF ELECTRICAL SYSTEMS.

1.4 SYSTEMS TO BE COMMISSIONED
   A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the Universities Operation and Maintenance personnel, is required in cooperation with the University and the Commissioning Authority.
B. The following systems will be commissioned as part of this project:

<table>
<thead>
<tr>
<th>Systems To Be Commissioned</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HVAC</strong></td>
<td></td>
</tr>
<tr>
<td>Direct Digital Control System**</td>
<td>Operator Interface Computer, Operator Work Station (including graphics, point mapping, trends, alarms), Network Communications Modules and Wiring, Integration Panels.  [DDC Control panels will be commissioned with the systems controlled by the panel]</td>
</tr>
<tr>
<td>HVAC Air Handling Systems**</td>
<td>Custom air handling Units, custom rooftop AHU, Outdoor Air conditioning units, humidifiers, DDC control panels</td>
</tr>
<tr>
<td>HVAC Ventilation/Exhaust Systems</td>
<td>General exhaust, toilet exhaust, laboratory exhaust, isolation exhaust, room pressurization control systems</td>
</tr>
<tr>
<td>HVAC Terminal Unit Systems**</td>
<td>VAV Terminal Units, CAV terminal units, fan coil units, fin-tube radiation, unit heaters</td>
</tr>
<tr>
<td><strong>Electrical – New Equipment Only</strong></td>
<td></td>
</tr>
<tr>
<td>Grounding &amp; Bonding Systems</td>
<td>Witness 3rd party testing, review reports</td>
</tr>
<tr>
<td>Electrical System Protective Device Study</td>
<td>Review reports, verify field settings consistent with Study</td>
</tr>
<tr>
<td>Low-Voltage Distribution System</td>
<td>Normal power distribution system, distribution system, critical power distribution system, equipment power distribution system, switchboards, distribution panels, panelboards, verify breaker testing results (injection current, etc)</td>
</tr>
</tbody>
</table>
1.5 COMMISSIONING TEAM

A. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and subcontractors, installers, schedulers, suppliers, and specialists deemed appropriate by the University and Commissioning Authority.

B. Members Appointed by Contractor:

1. Contractor’s Commissioning Manager: The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team.

2. Contractor’s Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions.

C. Members Appointed by the University:

1. Commissioning Authority: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The University will engage the CxA under a separate contract.

2. User: Representatives of the facility user and operation and maintenance personnel.

3. A/E: Representative of the Architect and engineering design professionals.

1.6 UNIVERSITY’S COMMISSIONING RESPONSIBILITIES

A. Appoint an individual, company or firm to act as the Commissioning Authority.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:

1. Coordination meetings.

2. Training in operation and maintenance of systems, subsystems, and equipment.

3. Testing meetings.


5. Demonstration of operation of systems, subsystems, and equipment.

C. Provide the Construction Documents, prepared by Architect and approved by University, to the Commissioning Authority and for use in managing the commissioning process, developing the commissioning plan, systems manuals, and reviewing the operation and maintenance training plan.
1.7 CONTRACTOR’S COMMISSIONING RESPONSIBILITIES
   A. The Contractor shall assign a Commissioning Manager to manage commissioning activities of the Contractor, and subcontractors.
   B. The Contractor shall ensure that the commissioning responsibilities outlined in these specifications are included in all subcontracts and that subcontractors comply with the requirements of these specifications.
   C. The Contractor shall ensure that each installing subcontractor shall assign representatives with expertise and authority to act on behalf of the subcontractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
      1. Participate in commissioning coordination meetings.
      2. Conduct operation and maintenance training sessions in accordance with approved training plans.
      3. Verify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
      4. Evaluate commissioning issues and commissioning observations identified in the Commissioning Issues and Benefits Log, field reports, test reports or other commissioning documents. In collaboration with entity responsible for system and equipment installation, recommend corrective action.
      5. Review and comment on commissioning documentation.
      7. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to Commissioning Authority for incorporation into the commissioning plan.
      8. Provide information to the Commissioning Authority for developing commissioning plan.
      9. Participate in training sessions for University’s operation and maintenance personnel.
     10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct Systems Functional Performance Testing of installed systems.

1.8 COMMISSIONING AUTHORITY’S RESPONSIBILITIES
   A. Organize and lead the commissioning team.
   B. Prepare the commissioning plan.
   C. Review and comment on selected submittals from the Contractor for general conformance with the Construction Documents.
At the beginning of the construction phase, conduct an initial construction phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; Pre-Functional Checklists, Systems Functional Performance Testing; and project completion.

Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss status of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The Commissioning Authority shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.

Observe construction and report progress, observations and issues. Observe systems and equipment installation for adequate accessibility for maintenance and component replacement or repair, and for general conformance with the Construction Documents.

Prepare Project specific Pre-Functional Checklists and Systems Functional Performance Test procedures.

Coordinate Systems Functional Performance Testing schedule with the Contractor.

Witness selected systems startups.

Verify selected Pre-Functional Checklists completed and submitted by the Contractor.


Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.

Review and comment on operation and maintenance (O&M) documentation and systems manual outline for compliance with the Contract Documents.

Review operation and maintenance training program developed by the Contractor. Verify training plans provide qualified instructors to conduct operation and maintenance training.

Prepare commissioning Field Observation Reports.

Prepare the Final Commissioning Report.

Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal Systems Functional Performance Testing. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the
O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

R. Assemble the final commissioning documentation, including the Final Commissioning Report and Addendum to the Final Commissioning Report.

1.9 COMMISSIONING DOCUMENTATION

A. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited, to the following:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.

2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.

3. Identification of systems and equipment to be commissioned.

4. Schedule of Commissioning Coordination meetings.

5. Identification of items that must be completed before the next operation can proceed.

6. Description of responsibilities of commissioning team members.

7. Description of observations to be made.

8. Description of requirements for operation and maintenance training.

9. Schedule for commissioning activities with dates coordinated with overall construction schedule.


11. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.


B. Systems Functional Performance Test Procedures: The Commissioning Authority will develop Systems Functional Performance Test Procedures for each system to be commissioned, including subsystems, or equipment and interfaces or interlocks with other systems. Systems Functional Performance Test Procedures will include
a separate entry, with space for comments, for each item to be tested. Preliminary Systems Functional Performance Test Procedures will be provided to the University, Architect/Engineer, and Contractor for review and comment. The Systems Performance Test Procedure will include test procedures for each mode of operation and provide space to indicate whether the mode under test responded as required. Each System Functional Performance Test procedure, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:

1. Name and identification code of tested system.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Dated signatures of the person performing test and of the witness, if applicable.
6. Individuals present for test.
8. Issue number, if any, generated as the result of test.

C. Pre-Functional Checklists: The Commissioning Authority will prepare Pre-Functional Checklists. If the contractor wishes to provide their own prefunctional checklists or start up reports, they may do so following approval of blank forms provided to the Cx Authority. Pre-Functional Checklists shall be completed and signed by the Contractor, verifying that systems, subsystems, equipment, and associated controls are ready for testing. The Commissioning Authority will spot check Pre-Functional Checklists to verify accuracy and readiness for testing. Inaccurate or incomplete Pre-Functional Checklists shall be returned to the Contractor for correction and resubmission.

D. Test and Inspection Reports: The Commissioning Authority will record test data, observations, and measurements on Systems Functional Performance Test Procedure. The report will also include recommendation for system acceptance or non-acceptance. Photographs, forms, and other means appropriate for the application shall be included with data. Commissioning Authority Will compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.

E. Corrective Action Documents: The Commissioning Authority will document corrective action taken for systems and equipment that fail tests. The documentation will include
any required modifications to systems and equipment and/or revisions to test procedures, if any. The Commissioning Authority will witness and document any retesting of systems and/or equipment requiring corrective action and document retest results.

F. Commissioning Issues and Benefits Log: The Commissioning Authority will prepare and maintain Commissioning Issues and Benefits Log that describes Commissioning Issues and Commissioning Observations that are identified during the Commissioning process. These observations and issues include, but are not limited to, those that are at variance with the Contract Documents. The Commissioning Issues and Benefits Log will identify and track issues as they are encountered, the party responsible for resolution, progress toward resolution, and document how the issue was resolved. The Master Commissioning Issues and Benefits Log will also track the status of unresolved issues.

G. Final Commissioning Report: The Commissioning Authority will document results of the commissioning process, including unresolved issues, and performance of systems, subsystems, and equipment. The Commissioning Report will indicate whether systems, subsystems, and equipment have been properly installed and are performing according to the Contract Documents. This report will be used by the University when determining that systems will be accepted. This report will be used to evaluate systems, subsystems, and equipment and will serve as a future reference document during University occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. The commissioning report will include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances with the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. Design Narrative documentation maintained by the Commissioning Authority.
2. Commissioning plan.
3. Pre-Functional Checklists completed by the Contractor, with annotation of the Commissioning Authority review and spot check.
4. Systems Functional Performance Test Procedures, with annotation of test results and test completion.
6. Listing of deferred and off season test(s) not performed, including the schedule for
1.10 SUBMITTALS

A. Commissioning Plan Submittal: Based on the Final Construction Documents and the Contractor's project team, the Commissioning Authority will prepare the Final Commissioning Plan as described in this section. The Commissioning Authority will submit three hard copies and three sets of electronic files of Final Commissioning Plan. The Contractor shall review the Commissioning Plan and provide any comments to the University. The Commissioning Authority will incorporate review comments into the Final Commissioning Plan as directed by the University.

B. Systems Functional Performance Test Procedure: The Commissioning Authority will submit preliminary Systems Functional Performance Test Procedures to the Contractor, and the University for review and comment. The Contractor shall return review comments to the University and the Commissioning Authority. The University will also return review comments to the Commissioning Authority. The Commissioning Authority will incorporate review comments into the Final Systems Functional Test Procedures to be used in Systems Functional Performance Testing.

C. Test and Inspection Reports: The Commissioning Authority will submit test and inspection reports to the University with copies to the Contractor and the Architect/Engineer.

D. Corrective Action Documents: The Commissioning Authority will submit the Issues and Benefits Log to the University PM with copies to the Contractor and Architect.

E. Final Commissioning Report Submittal: The Commissioning Authority will submit four sets of electronically formatted information of the final commissioning report to the University. The final submittal will incorporate comments as directed by the University.

F. Data for Commissioning:

1. The Commissioning Authority will request in writing from the Contractor specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Commissioning Plan.

2. The Commissioning Authority may request further documentation as is necessary for the commissioning process or to support other University data collection requirements, including Construction Operations Building Information Exchange (COBIE), Building Information Modeling (BIM), etc.

1.11 COMMISSIONING PROCESS

A. The Commissioning Authority will be responsible for the overall management of the
commissioning process as well as coordinating scheduling of commissioning tasks with the University and the Contractor. As directed by the University, the Contractor shall incorporate Commissioning tasks, including, but not limited to, Systems Functional Performance Testing (including predecessors) with the Master Construction Schedule.

B. Within 30 days of contract award, the Contractor shall designate a specific individual as the Commissioning Manager (CxM) to manage and lead the commissioning effort on behalf of the Contractor. The Commissioning Manager shall be the single point of contact and communications for all commissioning related services by the Contractor.

C. Within 30 days of contract award, the Contractor shall ensure that each subcontractor designates specific individuals as Commissioning Representatives (CXR) to be responsible for commissioning related tasks. The Contractor shall ensure the designated Commissioning Representatives participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. The Contractor shall ensure that all Commissioning Representatives shall have sufficient authority to direct their respective staff to provide the services required, and to speak on behalf of their organizations in all commissioning related contractual matters.

1.12 COORDINATION

A. Management: The Commissioning Authority will coordinate the commissioning activities with the University and Contractor. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.

B. Scheduling: The Contractor shall work with the Commissioning Authority and the University to incorporate the commissioning activities into the construction schedule. The Commissioning Authority will provide sufficient information (including, but not limited to, tasks, durations and predecessors) on commissioning activities to allow the Contractor and the University to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction as directed by the University.

C. Commissioning Meetings: The Commissioning Authority will conduct periodic meetings of the commissioning team to review status of commissioning activities, to discuss the Issues and Benefits Log, and to discuss upcoming commissioning process activities.

D. Systems Functional Performance Testing Coordination: The Contractor shall coordinate
testing 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. The Contractor shall coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.
PART 2 - EXECUTION

2.1 COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES

A. The following table outlines the roles and responsibilities for the Commissioning Team members during the Construction

<table>
<thead>
<tr>
<th>Construction Phase</th>
<th>CxA = Commissioning Authority</th>
<th>PM</th>
<th>A/E</th>
<th>PC</th>
<th>Notes</th>
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<tbody>
<tr>
<td><strong>Commissioning Roles &amp; Responsibilities</strong></td>
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<td>Category</td>
<td>Task Description</td>
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<td>Project Progress Meetings</td>
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<td>Controls Meeting</td>
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<td>Cx Plan &amp; Spec</td>
<td>Final Commissioning Plan</td>
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<td>A</td>
<td>R</td>
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<td>Schedules</td>
<td>Duration Schedule for Commissioning Activities</td>
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<td>A</td>
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<td>Document Reviews</td>
<td>TAB Plan Review</td>
<td>L</td>
<td>A</td>
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<td>Submittal and Shop Drawing Review</td>
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<td>A</td>
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<td>Review Contractor Equipment Startup Checklists</td>
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<td>Review Change Orders, ASI, and RFI</td>
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### Construction Phase

**Commissioning Roles & Responsibilities**

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<td>Final Functional Performance Test Protocols</td>
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<td>Reports and Logs</td>
<td>Status Reports</td>
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**Notes**

- CxA = Commissioning Authority
- PM = PM
- A/E = Design Arch/Engineer
- PC = Prime Contractor
- L = Lead
- P = Participate
- A = Approve
- R = Review
- O = Optional

B. The following table outlines the roles and responsibilities for the Commissioning Team members during the Acceptance Phase:
# Acceptance Phase

<table>
<thead>
<tr>
<th>Category</th>
<th>Task Description</th>
<th>CxA</th>
<th>PM</th>
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<td>Coordination</td>
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<td>Cx Plan &amp; Spec</td>
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<td>Schedules</td>
<td>Prepare Functional Test Schedule</td>
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<td>A</td>
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<td>Document Reviews</td>
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<td>Review Operations &amp; Maintenance Manuals</td>
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<td><strong>Commissioning Roles &amp; Responsibilities</strong></td>
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<td>O = Optional</td>
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<th>Category</th>
<th>Task Description</th>
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<td>Review TAB Report</td>
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<td>Site Observations</td>
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<td>Witness Selected Equipment Startup</td>
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</table>
3.2 STARTUP, INITIAL CHECKOUT, AND PRE-FUNCTIONAL CHECKLISTS
   A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems to Be Commissioned.
      1. Pre-Functional Checklists are important to ensure that the equipment and systems are hooked up and operational. These ensure that Systems Functional Performance Testing may proceed without unnecessary delays. Each system to be commissioned shall have a full Pre-Functional Checklist completed by the Contractor prior to Systems Functional Performance Testing. No sampling strategies are used.
         a. The Pre-Functional Checklist will identify the trades responsible for completing the checklist. The Contractor shall ensure the appropriate trades complete the checklists.
         b. The Commissioning Authority will review completed Pre-Functional Checklists and field-verify the accuracy of the completed checklist using sampling techniques.
      2. Startup and Initial Checkout Plan: The Contractor shall develop detailed startup plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been completed. Parties responsible for startup shall be identified in the Startup Plan and in the checklist forms.

3.3 DEFICIENCIES, NONCONFORMANCE, AND APPROVAL IN CHECKLISTS AND STARTUP
   A. The Contractor shall clearly list any outstanding items of the initial startup and Pre-Functional Checklist procedures that were not completed successfully, at the bottom of the procedures form. The procedures form and any outstanding deficiencies shall be provided to the University and the Commissioning Authority within two days of completion.
   B. The Commissioning Authority will review the report and will work with the Contractor to correct and verify deficiencies or uncompleted items. The Commissioning Authority will involve the University and others as necessary. The Contractor shall correct all areas that are noncompliant or incomplete. The Contractor shall submit an updated startup report and a Statement of Correction on the original noncompliance report.

3.4 PHASED COMMISSIONING
   A. The project may require startup and initial checkout to be executed in phases. This phasing shall be planned and scheduled in a coordination meeting of the University, Commissioning Authority, and the Contractor. Results will be added to
the master construction schedule and the commissioning schedule.

3.5 DDC SYSTEM TRENDING FOR COMMISSIONING

A. Trending is a method of testing as a standalone method or to augment manual testing. The Contractor shall trend any and all points of the system or systems as required for the commissioning Functional Testing Procedures.

3.6 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. This paragraph applies to Systems Functional Performance Testing of systems for all referenced specification Divisions.

B. Objectives and Scope: The objective of Systems Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. Systems Functional Performance Testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of noncompliant performance are identified and corrected, thereby improving the operation and functioning of the systems. In general, each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, fire alarm and emergency power) where there is a specified system response. The Contractor shall verify each sequence in the sequences of operation. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

C. Development of Systems Functional Performance Test Procedures: Before Systems Functional Performance Test procedures are written, the Contractor shall submit all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements found in the Contract Documents and approved submittals and shop drawings, the Commissioning Authority will develop specific Systems Functional Test Procedures to verify and document proper operation of each piece of equipment and system to be commissioned. The Contractor shall assist the Commissioning Authority in developing the Systems Functional Performance Test procedures as requested by the Commissioning Authority i.e. by answering questions about equipment, operation, sequences, etc. Prior to execution, the Commissioning Authority will provide a copy of the Systems Functional Performance Test procedures to the University, the Architect/Engineer, and the Contractor, who shall review the tests for feasibility, safety, equipment and warranty protection.

D. Purpose of Test Procedures: The purpose of each specific Systems Functional
Performance Test is to verify and document compliance with the stated criteria of acceptance given on the test form. Representative test formats and examples are found in the Commissioning Plan for this project. (The Commissioning Plan is issued as a separate document and is available for review.) The test procedure forms developed by the Commissioning Authority will include, but not be limited to, the following information:

1. System and equipment or component name(s)
2. Equipment location and ID number
3. Unique test ID number, and reference to unique Pre-Functional Checklists and startup documentation, and ID numbers for the piece of equipment
4. Date
5. Project name
6. Participating parties
7. A copy of the specific sequence of operations or other specified parameters being verified
8. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
9. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
10. A section for comments.
11. Signatures and date block for the Commissioning Authority. A place for the Contractor to initial to signify attendance at the test.

E. Test Methods: Systems Functional Performance Testing shall be achieved by manual testing (i.e. persons manipulate the equipment and observe performance) and/or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by standalone data loggers. The Contractor and Commissioning Authority shall determine which method is most appropriate for tests that do not have a method specified.

1. Simulated Conditions: Simulating conditions shall be allowed, although timing the testing to experience actual conditions is encouraged wherever practical.
2. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the
interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

3. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.

4. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 54 F, when the outside air temperature is above 54F, temporarily change the lockout setpoint to be 4F above the current outside air temperature.

F. Setup: Each function and test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pretest condition.

G. Testing Prerequisites: In general, Systems Functional Performance Testing will be conducted only after Pre-Functional Checklists have been satisfactorily completed. The air balancing and water balancing shall be completed before Systems Functional Performance Testing of air-related or water-related equipment or systems are scheduled. Systems Functional Performance Testing will proceed from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems will be checked.

K. Problem Solving: The Commissioning Authority will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor.
3.7 DOCUMENTATION, NONCONFORMANCE AND APPROVAL OF TESTS

A. Documentation: The Commissioning Authority will witness, and document the results of all Systems Functional Performance Tests using the specific procedural forms developed by the Commissioning Authority for that purpose.

B. Nonconformance: The Commissioning Authority will record the results of the Systems Functional Performance Tests on the procedure or test form. All items of nonconformance issues will be noted and reported to the University on Commissioning Field Reports and/or the Commissioning Master Issues and Benefits Log.

1. Corrections of minor items of noncompliance identified may be made during the tests. In such cases, the item of noncompliance and resolution shall be documented on the Systems Functional Test Procedure.

2. Every effort shall be made to expedite the systems functional Performance Testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Authority shall not be pressured into overlooking noncompliant work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so by direction from the University.

3. When there is no dispute on an item of noncompliance, and the Contractor accepts responsibility to correct it:

   a. The Commissioning Authority will document the item of noncompliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the Commissioning Authority will submit a Commissioning Field Report to the University. The Commissioning Authority will also note items of noncompliance and the Contractor's response in the Master Commissioning Issues and Benefits Log. The Contractor shall correct the item of noncompliance and report completion to the University and the Commissioning Authority.

   b. The need for retesting will be determined by the Commissioning Authority. If retesting is required, the Commissioning Authority and the Contractor shall reschedule the test and the test shall be repeated.

4. If there is a dispute about item of noncompliance, regarding whether it is an item of noncompliance, or who is responsible:
a. The item of noncompliance shall be documented on the test form with the
   Contractor's response. The item of noncompliance with the Contractor's
   response shall also be reported on the Master Commissioning Issues and
   Benefits Log.

b. Resolutions shall be made at the lowest management level possible. Other
   parties are brought into the discussions as needed. Final interpretive and
   acceptance authority is with the University of Missouri.

c. The Commissioning Authority will document the resolution process.

d. Once the interpretation and resolution have been decided, the Contractor shall
   correct the item of noncompliance, report it to the Commissioning Authority. The
   requirement for retesting will be determined by the Commissioning Authority. If
   retesting is required, the Commissioning Authority and the Contractor shall
   reschedule the test. Retesting shall be repeated until satisfactory performance is
   achieved.

E. Cost of Retesting: The cost to retest a System Functional Performance Test shall be
   solely the responsibility of the Contractor. Any required retesting by the Contractor shall
   not be considered a justified reason for a claim of delay or for a time extension by the
   Contractor.

3.8 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

A. Training Preparation Conference: Before operation and maintenance training, the
   Commissioning Authority will convene a training preparation conference to include
   University's PM, University's Operations and Maintenance personnel, and the Contractor.
   The purpose of this conference will be to discuss and plan for Training and
   Demonstration of University Operations and Maintenance personnel.

B. The Contractor shall provide training and demonstration as required by other Division 23
   and Division 26 sections. The Training and Demonstration shall include, but is not limited to,
   the following:
   1. Review the Contract Documents.
   2. Review installed systems, subsystems, and equipment.
   3. Review instructor qualifications.
   4. Review instructional methods and procedures.
   5. Review training module outlines and contents.
   6. Review course materials (including operation and maintenance manuals).
   7. Review and discuss locations and other facilities required for instruction.
   8. Review and finalize training schedule and verify availability of educational materials,
instructors, audiovisual equipment, and facilities needed to avoid delays.

9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

----- END -----
SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Shop fabricated \{CH#29007\} \{CH#29008\}

PART 2 PRODUCTS
2.01 MATERIALS - STEEL
   A. Steel Sections: ASTM A36/A36M.
   B. Slotted Channel Framing: ASTM A653/A653M, Grade 33.
   C. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
   D. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATED ITEMS
   A. Ledge Angles and Shelf Angles Not Attached to Structural Framing: For support of masonry; galvanized finish.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install items plumb and level, accurately fitted, free from distortion or defects.
   B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
   C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION
SECTION 07 05 53
FIRE AND SMOKE ASSEMBLY IDENTIFICATION

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Identification markings for fire and smoke rated partitions, and fire rated walls.

PART 2 PRODUCTS
2.01 FIRE AND SMOKE ASSEMBLY IDENTIFICATION

PART 3 EXECUTION
3.01 INSTALLATION
   A. Locate markings as required by ICC (IBC).
   B. Install neatly, with horizontal edges level.
   C. Protect from damage until Date of Substantial Completion; repair or replace damaged markings.

END OF SECTION
SECTION 07 72 00
ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Curbs.
B. Equipment rails.

1.02 RELATED REQUIREMENTS
A. Section 23 05 29- Hangers and Supports for HVAC Piping and Equipment

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used.
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Maintenance requirements.
C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.

PART 2 PRODUCTS

2.01 ROOF CURBS
A. Manufacturers:
   1. AES Industries Inc: www.aescurb.com/#sle.
   2. The Pate Company: www.patecurbs.com/#sle.
   6. Substitutions: See Section 01 60 00 - Product Requirements.
B. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
   1. Applications: Roof curbs used for roof penetrations/openings as indicated on drawings.
   2. Roof Curb Mounting Substrate: Curb substrate consists of flat roof deck sheathing with insulation.
   3. Sheet Metal Material:
      a. Aluminum: 0.080 inch (2.03 mm) minimum thickness, with 3003 alloy, and H14 temper.
   4. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches (102 mm).
5. Provide layouts and configurations indicated on drawings.

C. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
   1. Provide preservative treated wood nailers along top of curb.
   2. Insulate inside curbs with 1-1/2 inch (38 mm) thick fiberglass insulation.
   3. Height Above Finished Roof Surface: 8 inches (203 mm), minimum.

D. Equipment Rail Curbs: Straight curbs on each side of equipment, with top of curbs horizontal and level with each other for equipment mounting.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

B. Install non-penetrating support assemblies on roof protection pads compatible with existing roof system.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Repair of existing fireproofing on interior structural steel not exposed to damage or moisture.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.

1.03 QUALITY ASSURANCE
   A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.04 FIELD CONDITIONS
   A. Do not apply fireproofing when temperature of substrate material and surrounding air is below 40 degrees F (4 degrees C) or when temperature is predicted to be below said temperature for 24 hours after application.
   B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
   C. Provide temporary enclosure to prevent spray from contaminating air.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Applied Fireproofing:

2.02 FIREPROOFING ASSEMBLIES
   A. Verify existing minimum fire resistance ratings in the project areas with Owner or Authorities Having Jurisdiction.
   B. For areas requiring repair of fireproofing assemblies to achieve minimum fire resistance ratings, provide assemblies which meet verified existing requirements.
   C. If existing required fire resistance ratings cannot be verified, provide required repairs with the following minimum fire resistance ratings for the following building elements:
      1. Primary structural frame, including columns, girders, and trusses, 2 hours.
      2. Roof construction, including supporting beams and joists, 2 hours.

2.03 MATERIALS
   A. Applied Fireproofing Material for Interior Applications, Concealed: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
      1. Bond Strength: 150 pounds per square foot (7.2 kPa), minimum, when tested in accordance with ASTM E736 when set and dry.
      2. Compressive Strength: 8.33 pounds per square inch (57.4 kPa), minimum.
3. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760.

4. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937.

5. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.01 REPAIR

A. Examine existing fireproofing and identify areas where remaining fireproofing does not meet project requirements and requiring repair or replacement.

1. Where fireproofing requires repair or replacement, notify Owner of any existing conditions (including roof, plumbing, or equipment leaks) related to damaged or missing fireproofing and, if possible, recommend appropriate action to prevent future damage.

B. Protect existing fireproofing that remains in good condition.

C. Prepare surfaces requiring repair and apply fireproofing as described below.

3.02 EXAMINATION

A. Verify that surfaces are ready to receive fireproofing.

B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.

C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.

D. Verify that voids and cracks in substrate have been filled.

E. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.03 PREPARATION

A. Perform tests as recommended by fireproofing manufacturer in applications where adhesion of fireproofing to substrate is in question.

B. Remove incompatible materials that could effect bond by scraping, brushing, scrubbing, or sandblasting.

C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.

D. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.

E. Close off and seal duct work in areas where fireproofing is being applied.

3.04 APPLICATION

A. Apply primer adhesive in accordance with manufacturer's instructions.

B. Apply fireproofing in uniform thickness and density as necessary to achieve required ratings.

3.05 CLEANING

A. Remove excess material, overspray, droppings, and debris.

B. Remove fireproofing from materials and surfaces not required to be fireproofed.
SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Firestopping systems.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly and firestopping test or design number.
C. Product Data: Provide data on product characteristics, performance ratings and limitations.

1.03 QUALITY ASSURANCE
A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in UL (FRD), FM (AG) or ITS (DIR) will be considered as constituting an acceptable test report.
   2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
   3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Firestopping Manufacturers:

2.02 MATERIALS
A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS
A. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.04 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS
A. Penetrations By:
   1. Uninsulated Metallic Pipe, Conduit, and Tubing:
      a. 1 Hour Construction: UL System W-L-1049; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
      b. 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
      c. 1 Hour Construction: UL System W-L-1090; Specified Technologies Inc. LC Endothermic Firestop Sealant.
      d. 1 Hour Construction: UL System W-L-1164; Hilti FS-ONE MAX Intumescent Firestop Sealant.
2. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
   a. 1 Hour Construction: UL System W-L-2048; Specified Technologies Inc. SSW wrap strips.
   b. 1 Hour Construction: UL System W-L-2074; Specified Technologies Inc. SSC collars.
   c. 1 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
   d. 1 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   e. 1 Hour Construction: UL System W-L-2237; Specified Technologies Inc. LCC Intumescent Firestop Collars.
   f. 1 Hour Construction: UL System W-L-2243; Specified Technologies Inc. SSW wrap strips.
   g. 1 Hour Construction: UL System W-L-2493; Specified Technologies Inc. RTC range-taking collar.

3. Insulated Pipes:

2.05 FIRESTOPPING SYSTEMS
   A. Firestopping: Any material meeting requirements.
      1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR) or UL (FRD) and tested in accordance with ASTM E814, ASTM E119 or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION
   A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
   B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION
   A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
   B. Do not cover installed firestopping until inspected by authorities having jurisdiction.
   C. Install labeling required by code.

3.04 FIELD QUALITY CONTROL
   A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174, and ASTM E2393.
B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

END OF SECTION
SECTION 08 06 71
DOOR HARDWARE SCHEDULE

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Preliminary schedule of door hardware sets for swinging as indicated on drawings.

1.02 RELATED REQUIREMENTS
   A. Section 08 71 00 - Door Hardware: Requirements to comply with in coordination with this section.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Only manufacturers listed in Door Hardware Schedule or Section 08 71 00 are considered acceptable, unless noted otherwise.
   B. Obtain each type of door hardware as indicated from a single manufacturer and single supplier.
   C. Manufacturer's Abbreviations: Coordinate with manufacturers listed in Section 08 71 00.

2.02 LOCK FUNCTION CODES
   A. Function Codes for Mortise Locks: Complying with BHMA A156.13.
      1. Code F01; Passage/Closet Latchset: Latch bolt by knobs at all times.

2.03 FINISHES
   A. Finishes: Complying with BHMA A156.18.
      1. Code 626: Satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D).

PART 3 EXECUTION
3.01 DOOR HARDWARE SCHEDULE
   A. Organize listing of door hardware components within each hardware set in compliance with 10-Part scheduling sequence indicated in DHI (H&S), unless otherwise indicated.

3.02 HARDWARE SET # 01: "EQUIPMENT ROOM"
   A. Provide for each Single (SGL) door.

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<tr>
<th>UNITS</th>
<th>LOCK</th>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>FINISH</th>
<th>MFR</th>
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<td>PERMANENT CORE</td>
<td>OWNER SUPPLIED</td>
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<td>4011</td>
<td>689</td>
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<tr>
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<td>MOUNTING PLATE</td>
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</table>
SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fire-rated hollow metal doors and frames.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Hollow Metal Doors and Frames:

2.02 PERFORMANCE REQUIREMENTS
A. Requirements for Hollow Metal Doors and Frames:
   1. Steel Sheet: Comply with one or more of the following requirements; galvannealed steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
   2. Accessibility: Comply with ICC A117.1 and ADA Standards.
   3. Door Edge Profile: Manufacturers standard for application indicated.
B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS
A. Door Finish: Factory primed and field finished.
B. Fire-Rated Doors:
   1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
      a. Level 1 - Standard-duty.
      b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 20 gage, 0.032 inch (0.8 mm), minimum.
2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
   a. Attach fire rating label to each fire rated unit.
4. Door Thickness: 1-3/4 inch (44.5 mm), nominal.

2.04 HOLLOW METAL FRAMES
   A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
   B. Door Frames, Fire-Rated: Knock-down type.
      1. Fire Rating: Same as door, labeled.

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

2.06 ACCESSORIES
   A. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
   B. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
   B. Install fire rated units in accordance with NFPA 80.
   C. Coordinate frame anchor placement with wall construction.
   D. Install door hardware as specified in Section 08 71 00.

END OF SECTION
SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hardware for {CH#229962} doors.
B. Hardware for fire-rated doors.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
C. Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
   1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
   2. Provide complete description for each door listed.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
B. Provide individual items of single type, of same model, and by same manufacturer.
C. Provide door hardware products that comply with the following requirements:
   1. Applicable provisions of federal, state and local codes.
   2. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
   3. Hardware on Fire-Rated Doors: Listed and classified by testing firm acceptable to authorities having jurisdiction as suitable for application indicated.

2.02 MORTISE LOCKS

A. Mortise Locks: Comply with BHMA A156.13, Grade 1, Security, 1000 Series.
   1. Latchbolt Throw: 3/4 inch (19 mm), minimum.
   2. Deadbolt Throw: 1 inch (25.4 mm), minimum.
   3. Backset: 2-3/4 inch (70 mm) unless otherwise indicated.
   4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
      a. Finish: To match lock or latch.

2.03 FINISHES

A. Finishes: Identified in Section 08 0671 - Door Hardware Schedule.

PART 3 EXECUTION

IMEG #18004255.00
UM Women's and Children's Hospital
Air Handling Unit Replacement
3.01 INSTALLATION
   A. Install hardware in accordance with manufacturer’s instructions and applicable codes.
   B. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
   C. Use templates provided by hardware item manufacturer.
   D. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item.
      1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.
B. Metal stud wall framing.
C. Metal channel ceiling framing.
D. Gypsum wallboard.
E. Joint treatment and accessories.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.
B. Fire Rated Assemblies: Provide completed assemblies with the following characteristics:
   1. Fire Rated Partitions: UL listed assembly No. U419; 1 hour rating.
   2. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.02 METAL FRAMING MATERIALS

A. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf (L/120 at 240 Pa).
   1. Studs: "C" shaped with flat or formed webs with knurled faces.
   2. Runners: U shaped, sized to match studs.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Thickness:

2.04 GYPSUM WALLBOARD ACCESSORIES

A. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
   1. Types: As detailed or required for finished appearance.
B. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION
A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
B. Studs: Space studs at 16 inches on center (at 406 mm on center).
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

3.03 BOARD INSTALLATION
A. Comply with ASTM C840, GA-216 and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
B. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

3.04 INSTALLATION OF TRIM AND ACCESSORIES
A. Corner Beads: Install at external corners, using longest practical lengths.

3.05 JOINT TREATMENT
A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).

END OF SECTION
SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Suspended metal grid ceiling system.
   B. Acoustical units.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on suspension system components and acoustical units.
   C. Evaluation Service Reports: Show compliance with specified requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Acoustic Tiles/ Panels:
   B. Suspension Systems:
      1. Same as for acoustical units.

2.02 PERFORMANCE REQUIREMENTS
   A. Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions determined according to ASCE 7 for Seismic Design Category C and complying with the following:
      1. Local authorities having jurisdiction.

2.03 ACOUSTICAL UNITS
   A. Acoustical Units - General: ASTM E1264, Class A.
      1. VOC Content: Certified as Low Emission by one of the following:
         a. Product listing in UL (GGG).
         b. Product listing in CHPS (HPPD).
   B. Acoustical Panels: Mineral fiber with scrubbable finish, with the following characteristics:
      1. Classification: ASTM E1264 Type IX.
      2. Size: 24 by 24 inches (610 by 610 mm).
      3. Thickness: 3/4 inch (19 mm).

2.04 SUSPENSION SYSTEM(S)
   A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips and splices as required.
B. Exposed Suspension System: Hot-dipped galvanized steel grid with aluminum cap.
   1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
   2. Profile: Tee; 15/16 inch (24 mm) face width.
   3. Finish: Baked enamel.

2.05 ACCESSORIES
   A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
   B. Hanger Wire: 12-gage 0.08 inch (2 mm) galvanized steel wire.
   C. Seismic Clips: Manufacturer's standard clips for seismic conditions and to suit application.
   D. Perimeter Moldings: Same metal and finish as grid.

PART 3 EXECUTION

3.01 INSTALLATION - SUSPENSION SYSTEM
   A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
   B. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
      1. Use longest practical lengths.
   C. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
   D. Seismic Suspension System, Seismic Design Category C: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Maintain a 3/8 inch (9 mm) clearance between grid ends and wall.
   E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
   F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
   G. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.
   H. Do not eccentrically load system or induce rotation of runners.

3.02 INSTALLATION - ACOUSTICAL UNITS
   A. Install acoustical units in accordance with manufacturer's instructions.
   B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
   C. Fit border trim neatly against abutting surfaces.
   D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
   E. Cutting Acoustical Units:
      1. Make field cut edges of same profile as factory edges.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanical demolition.
B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, this Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

A. Disconnect fire protection systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.
3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned piping to source of supply and/or main lines.

C. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

D. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.4 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 21 05 29 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. FIRE PROTECTION ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.
SECTION 21 05 29
FIRE SUPPRESSION SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.
B. Equipment Bases and Supports.
C. Sleeves and Seals.
D. Flashing and Sealing of Equipment and Pipe Stacks.
E. Cutting of Openings.
F. Escutcheon Plates and Trim.

1.2 QUALITY ASSURANCE

A. Support Sprinkler Piping in conformance with NFPA 13.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 1.

1.4 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

A. Refer to Section 21 05 50 for additional requirements for seismic restraints.

2.2 HANGER RODS

A. Hanger rods for single rod hangers supporting steel, copper, and CPVC piping shall conform to the following:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>4” and smaller</td>
<td>3/8”</td>
</tr>
</tbody>
</table>

B. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.3 PIPE HANGERS AND SUPPORTS

A. General:

1. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, 69, 89, and 127 (where applicable).

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story
structures, and more frequently when required by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings or lugs. Provide sufficient flexibility to accommodate expansion and contraction without compromising fire barrier penetrations and other fixed takeoff locations.

Acceptable Products:

- Anvil - Fig. CT121
- Cooper/B-Line - Fig. B3373CT
- Erico - Model 510
- Nibco/Tolco - Fig. 82

2. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.

3. **Masonry Anchors:** Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.

2. Unless otherwise indicated, hangers shall be as follows:

   a. **Clevis Type:**
      - Service: Bare Metal Pipe
      - Acceptable Products:
        - Anvil: Fig. 260
        - Cooper/B-Line: Fig. 3100
        - Erico: Model 400
        - Nibco/Tolco: Fig. 1

   b. **Adjustable Swivel Ring Type:**
      - Service: Bare Metal Pipe - 4 inches and Smaller
      - Acceptable Products:
        - Anvil: Fig. 69
        - Cooper/B-Line: Fig. B3170NF
        - Erico: Model FCN
        - Nibco/Tolco: Fig. 200

3. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer’s installation requirements for structural support of piping. Clamps
shall not interrupt piping insulation.

4. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

5. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

   a. **Clamp Type:**

      Service: Bare Metal Pipe

      1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.

      2) Acceptable Products:

         | Unistrut            | Cooper/B-Line       | Nibco/Tolco     |
         | Fig. P1100 or P2500 | Fig. B2000 or B2400 | Fig. A-14 or 2STR |

   D. **Upper (Structural) Attachments:**

   1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

      a. **Steel Structure Clamps:**

         1) C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):

            Acceptable Products:

            | Anvil       | Cooper/B-Line    | Erico    | Nibco/Tolco |
            | Fig. 92     | Fig. B3033/B3034 | Model 300 | 68          |

         2) Scissor Type Beam Clamps (for use with bar-joists and wide flange):

            Acceptable Products:

            | Anvil       | Cooper/B-Line    | Erico    | Nibco/Tolco |
            | Fig. 228, 292 | Fig. B3054     | Model 360 | Fig. 329    |

      b. **Concrete:**

         1) **Concrete Anchors:** Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
2) Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

c. Steel Structure Welding:

1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

2.4 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.

2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.

2. Hang heavy equipment from concrete floors or ceilings with Architect-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

C. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.

2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.

3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.5 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or
additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.6 PIPE SLEEVES AND LINTELS

A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor’s work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1” above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer’s design.

F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4” resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.7 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.
2.8 PIPE PENETRATIONS
A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.9 PIPE ANCHORS
A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.10 FINISH
A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 FIRE SUPPRESSION SUPPORTS AND ANCHORS
A. General Installation Requirements:
   1. Install all items per manufacturer's instructions.
   2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
   3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
   4. Supports shall extend directly to building structure. Do not support piping from duct hangers. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:
   1. Install roof pipe supports to resist wind movement per manufacturer’s recommendations. Method of securing base to roof shall be compatible with roofing materials.
   2. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
   3. Set all concrete inserts in place before pouring concrete.
   4. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
   5. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
6. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.

4. Piping shall not introduce strains or distortion to connected equipment.

5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.

6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.

7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.

8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3” spacing between loads.

2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
   a. The hanger is attached within 6” from a web/chord joint.
   b. Additional L2x2x1/4 web reinforcement is installed per manufacturer’s requirements.

3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.

4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4” below bottom face of lowest fastener and blunt any sharp edges.
F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Spacing of hangers shall in no case exceed the following:

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Steel (All steel pipe unless otherwise noted):</td>
<td></td>
</tr>
<tr>
<td>1-1/4&quot; &amp; under</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot; &amp; larger</td>
<td>15'-0&quot;</td>
</tr>
<tr>
<td>2. Steel (Schedule 40 lightweight alternative):</td>
<td></td>
</tr>
<tr>
<td>3&quot; &amp; under</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>3. Hard Drawn Copper:</td>
<td></td>
</tr>
<tr>
<td>1&quot; &amp; under</td>
<td>8'-0&quot;</td>
</tr>
<tr>
<td>1-1/4&quot; to 1-1/2&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>2&quot; to 3&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>3-1/2&quot; &amp; larger</td>
<td>15'-0&quot;</td>
</tr>
</tbody>
</table>

I. Installation of hangers shall conform to MSS SP-58, 69, 89, and applicable NFPA standards.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.

2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.

3. These requirements are beyond those listed in Section 21 05 29 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.

2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

D. Installer: Company specializing in performing the work of this Section.

E. Suppliers: Following is a partial list of manufacturer/supplier contact information for seismic restraints:

2. Unistrut Corporation http://www.unistrut.us/
7. ISAT 877.523.6060, www.isatsb.com

1.3 SUBMITTALS

A. Submit under provisions of Division 1.
B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.

2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.

3. Manufacturer’s Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer’s certifications of compliance.

4. System Supports/Restraints - Submit for each condition requiring seismic bracing:
   a. Calculations for each seismic brace and detail utilized on the project.
   b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
   c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
   d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Equipment - Submit for each piece of equipment supplied:
   a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
   b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
   c. Engineering calculations and details for equipment anchorage and support structure.

C. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.

1.4 TESTING AND INSPECTION

A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the International Building Code.

B. The Contractor shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.
C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency’s knowledge, in conformance with the approved plans and specifications shall be submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer’s instructions for storage.

1.6 DESIGN REQUIREMENTS

A. This project is subject to the seismic bracing requirements of the International Building Code, 2018 edition.

B. The following criteria are applicable to this project:

1. Risk Category: IV
2. Seismic Factor: $I_E = 1.5$
3. Seismic Design Category: D
4. Component Amplification Factors ($a_p$) and Component Response Modification Factors ($R_p$) shall be taken from Table 13.5-1 in ASCE 7-16 for the individual equipment or system being restrained.
5. Component Importance Factors ($I_p$) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
6. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

C. Forces shall be calculated with the above requirements and Equation 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4

D. Equipment shall meet International Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

E. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.
1.7 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

1.8 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SEISMIC DESIGN CRITERIA

A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.

B. Definitions

1. Stay in Place:
   a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2. Remain Operational:
   a. Requirements for “Stay in Place” listed above shall be met.
   b. The following systems and associated equipment are intended not to fail externally or internally and are intended to remain operational.
      1) Fire Protection

2.2 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.

2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer’s submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.

3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.

4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.
5. All seismic restraint devices shall be designed to accept without failure the forces
calculated per the applicable building code.

6. All seismic restraints and combination isolator/restraints shall have verification of
their seismic capabilities witnessed by an independent testing agency.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Housekeeping Pads:

1. Reinforced housekeeping pads shall be provided to handle shear, tension, and
compression forces with proper reinforcement, doweling, and attachments
connecting the pad to the structural slab.

2.3 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.

2.4 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to
authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall
be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with
IBC, ACI and ICC ES requirements for cracked concrete anchors.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125,
Grade A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not
acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically
rated rigid equipment mountings and matched to the type and size of anchor bolts and
studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene
elements and steel sleeves designed for seismically rated rigid equipment mountings and
matched to the type and size of attachment devices used.
2.5 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.

B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.

C. All seismic restraint systems shall be installed in strict accordance with the manufacturer’s written instructions and all certified submittal data.

D. Installation of seismic restraints shall not cause any change in position of equipment, piping, or ductwork, resulting in stresses or misalignment.

E. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

F. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.

G. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer’s attention prior to specific equipment selection.

H. Prior to installation, bring to the Architect/Engineer’s attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

I. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.
J. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.

K. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

L. Do not install cables over sharp corners.

M. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

N. Provide reinforced clevis bolts when required.

O. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

P. Post-Installed anchors shall be provided to meet seismic requirements.

Q. Vertical pipe risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.

R. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

S. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.

T. Do not brace a system to two different structures such as a wall and a ceiling.

U. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

V. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

W. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.

X. Coordinate seismic bracing of architecturally exposed ductwork with the Architect/Engineer.

3.2 SEISMIC RESTRAINT EXCLUSIONS

A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION
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SECTION 21 05 53
FIRE SUPPRESSION IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Identification of products installed under Division 21.

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Section 21 05 00. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS


2.2 MATERIALS

A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<table>
<thead>
<tr>
<th>OD of Pipe or insulation</th>
<th>Marker Length</th>
<th>Size of Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 1-1/4&quot;</td>
<td>8&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>1-1/2” to 2”</td>
<td>8&quot;</td>
<td>3/4”</td>
</tr>
<tr>
<td>2-1/2” to 6”</td>
<td>12&quot;</td>
<td>1-1/4&quot;</td>
</tr>
</tbody>
</table>

Plastic tags may be used for outside diameters under 3/4".

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2” round.

F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturer’s recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:
   1. All valves (except shutoff valves at equipment) shall have numbered tags.
   2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
   3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
   4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
   5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
   6. Number all tags and show the service of the pipe.

D. Pipe Markers:
   1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
   2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
   3. Stencil Painted Pipe Markers:
      a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
      b. Apply primer on non-insulated pipes before painting.
      c. Use background and letter colors as scheduled later in this section.
   4. Apply markers and arrows in the following locations where clearly visible:
      a. At each valve.
      b. On both sides of walls that pipes penetrate.
      c. At least every 20 feet along all pipes.
      d. On each riser and each leg of each "T" joint.
      e. At least once in every room and each story traversed.
E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.

2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with the text as shown in the following table regardless of which method or material is used:

<table>
<thead>
<tr>
<th>Pipe Service</th>
<th>Lettering Color</th>
<th>Background Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRE PROTECTION WATER</td>
<td>White</td>
<td>Red</td>
</tr>
<tr>
<td>SPRINKLER WATER</td>
<td>White</td>
<td>Red</td>
</tr>
</tbody>
</table>

B. All piping downstream of the fire protection backflow preventer, upstream of sprinkler zone valves, standpipe piping, and combination sprinkler standpipe piping shall be labeled Fire Protection Water. All piping downstream of sprinkler zone valves shall be labeled Sprinkler Water.

END OF SECTION
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PART 1 - GENERAL

1.1 SECTION INCLUDES

B. Wet-Pipe Sprinkler System.

1.2 QUALITY ASSURANCE

B. Devices and equipment for fire protection service shall be UL Fire Prot Dir listed or FM P7825 approved for use in wet pipe sprinkler systems.
C. Valves: Bear UL/FM label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.
D. Specialist Firm: Company specializing in sprinkler systems with minimum three years' experience.
E. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE, and signed and sealed by a Professional Engineer licensed in the state where the project is located.
F. Computer calculations and or computer aided designs may be used to provide hydraulic calculations.

1.3 SUBMITTALS

A. Submit shop drawings per Section 21 05 00. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.
B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.
C. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.
D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
F. Prepare Minimum 24 by 36 inch detail working drawings of sprinkler heads and piping system layout in accordance with NFPA 13, "Working Drawings (Plans)." Show data essential for proper installation of each system. Show details, plan view, elevations, and...
sections of the systems supply and piping. Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams. Submit drawings including the hydraulic calculations signed and stamped by a registered fire protection engineer.

G. Fire Sprinkler shop drawings shall be submitted for review and approval PRIOR to installation. The plans will be reviewed by: Maintenance Engineer /Fire Protection shop, City of Columbia Fire Marshal, and Design Engineer

1.4 EXTRA STOCK

A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store valves and sprinklers in shipping containers, with labels in place.
B. Provide temporary protective coating on iron and steel valves.
C. Maintain temporary end caps and closures in place until installation.

1.6 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves to General Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

1.7 SYSTEM DESCRIPTION

A. Contractor shall design and modify the existing water-based fire protection systems for the areas noted on the contract documents.
B. Sprinkler systems shall be designed and installed according to the following standard(s):
   1. FM Global Datasheets 2-0 - Installation Guideline for Automatic Sprinklers
   2. FM Global Datasheet 3-26 – Fire Protection Water Demand for Nonstorage Sprinklered Properties
C. Automatic wet pipe fire extinguishing sprinkler systems shall be designed in accordance with the required and advisory provisions of NFPA 13 by hydraulic calculations for uniform distribution of water over the design area.
D. System design and installation shall include all requirements by the Authority Having Jurisdiction, local and state building codes, and Owner’s insurance company in addition to the previously listed design standard(s). Those requirements shall take precedence over the contract documents in the case of discrepancies.
E. Systems shall be hydraulically calculated in accordance with the applicable design standard(s). Contractor is responsible for final pipe sizing based on results from hydraulic calculations. Pipe sizing shown on drawings for service entrance and main risers is preliminary and for coordination purposes only.
F. Discharge from individual heads in the hydraulically most remote area shall be between 100 percent and 120 percent of the specified density.
G. The water supply source for this project is the following:
   1. Public waterworks system with fire pump.
      a. The system design shall be based on water supply information provided on the contract drawings. Supply shall be presumed to be at the point of connection to existing water supply infrastructure unless noted otherwise. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 12 months.
      b. System design shall provide a safety factor when comparing available water supply pressure versus system design pressure at design flow rate (including hose streams). The safety factor shall be the following:
         1) 5 psig

H. Coordinate with Plumbing Contractor for installation of a floor drain with collection funnel below the backflow preventer.

I. Provide service shutoff valve in the sprinkler main with a post indicator wall indicator assembly.

J. Provide pressure gauge with valve in the main riser.

K. Provide main drain valve piped to outside the building sump pit hub drain, piped to the sanitary system. Locate so discharge does not damage lawn or other surfaces.

L. Provide flow switch in the main riser and as indicated on drawings.

M. Each system shall include materials, accessories, and equipment inside and outside the building to provide each system complete and ready for use. Design and install each system to consider blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed working drawings to be submitted for approval.

N. Calculate losses in piping in accordance with the Hazen-Williams formula with ‘C’ value of 120 for steel piping.

O. Base hydraulic calculations on a static pressure of [_____] psig with [_____] gpm available at a residual pressure of [_____] psig at the base of the sprinkler piping riser.

P. All sprinkler heads in a building shall be of the same manufacturer.
   1. Only new equipment and pipe shall be used. All equipment shall be UL listed and FM approved.

1.8 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 21 05 00 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit manufacturers’ operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.
1.10 JOB CONDITIONS

A. Fire Protection Contractor shall determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.

B. Local fire authority or third-party consultant shall be contracted to determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 6 months.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS

A. Piping – 2” and Under:
   1. Design Pressure: 175 psig
   3. Joints: Threaded, grooved, or flanged.
   4. Fittings:
      a. Threaded:
         1) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.4.
         2) Malleable iron, Class 150, black, UL/FM, ANSI/ASME B16.3.
         3) Ductile iron, Class 150, black, UL/FM, ANSI/ASME B16.3.
      b. Grooved:
         1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL/FM, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for -40°F to 150°F. Carbon steel bolts and nuts.
      c. Flanged:
         1) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.1.
   5. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.

B. Piping – 2-1/2” and Above:
   1. Design Pressure: 175 psig
a. Joints: Grooved or flanged.

b. Fittings:

1) Grooved:
   a) Ductile iron housing ASTM A-536, Grade 65-45-12, UL/FM, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for -40°F to 150°F. Carbon steel bolts and nuts.

2) Flanged:
   a) Cast iron, Class 125, black, UL/FM, ANSI/ASME B16.1.

2.2 FLEXIBLE FIRE SPRINKLER CONNECTIONS

A. Flexible Connection: Stainless steel hose, 175 psig max working pressure, fully welded non-mechanical fittings, stainless steel braid, maximum of 6' hose length, leak-tested with a minimum 7/8" internal corrugated hose diameter made of 304 stainless steel, end fittings made of carbon or stainless steel. Outlet of end fittings shall be 1/2" or 3/4" to match sprinkler connection. UL/FM.

B. Ceiling Bracket: G90 galvanized steel, direct attachment type, integrated snap-on clip ends, tamper resistance screws, removable attachment hub with set screw for attachment and adjustment of stainless steel hose.

C. Acceptable Manufacturers: Flexhead Industries, Victaulic VicFlex, Sprinkflex, or approved equal.

2.3 VALVE OPERATORS

A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.

2.4 VALVE CONNECTIONS

A. Provide all connections to match pipe joints. Valves shall be same size as pipe.

2.5 EQUIPMENT

A. Equipment shall be as scheduled on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION - PIPING

A. General Installation Requirements:

1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.

2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.

3. Die cut screw joints with full cut standard taper pipe threads.
4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer’s installation instructions.
11. Locate sprinkler heads in a consistent pattern with ceiling grid, lights, and air supply diffusers. Heads in relation to the ceiling and the spacing of sprinkler heads shall not exceed that permitted by NFPA 13 for the indicated hazard occupancy.

B. Steel Piping:
1. In steel piping, main sized saddle branch connections or direct connection of branches to main is permitted if main is one pipe size larger than the branch for up to 6” mains and if main is two pipe sizes larger than branch for 8” and larger mains. Do not project branch pipes into main pipes.

C. Wall/Floor Penetration:
1. Provide sleeves when penetrating floors and walls.
2. Seal pipes passing through exterior walls with a wall seal per Section 21 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe. Sleeves through floors shall extend minimum 1.5” above finished floor.
3. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

D. Installation Requirements in Electrical Rooms:
1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

E. Hangers and Supports:
1. Provide hangers and supports as required by NFPA 13 and UL/FM, with the following exceptions:
   a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
   b. Do not install fasteners to carry the load in tension, unless absolutely necessary.
2. All fire protection piping shall be supported independently of all other building systems.

F. Exposed Piping:
1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.

3.2 INSTALLATION - VALVES
A. Install gate valves with stems upright or horizontal, not inverted.

B. Shutoff Valve:
1. Install buried shutoff valves in valve boxes. Provide post indicators.
2. Provide drain valves at main shutoff valves, low points of piping and apparatus.
3. Provide monitor switches on all shutoff valves.

3.3 INSTALLATION - EQUIPMENT
A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.

B. Test Valves:
1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.

C. Sprinklers:
1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

3.4 SYSTEMS CLEANING AND TESTING
A. General Requirement:
1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.

B. Interior Piping:
1. Verify adequate water flow at the inspector's test connection.
2. Flush all interior piping to remove scale and other foreign material before placing system into service.
3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig more than the normal system working pressure for systems subjected to pressures more than 150 psig. Maintain test pressure for 2 hours without loss of pressure.

C. Fire Alarm System:

1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.

2. Adjust all monitor switches for proper operation.

END OF SECTION
SECTION 23 05 05
HVAC DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanical demolition.
B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.
C. Existing Heating System: Maintain existing system in service until new system is complete and ready for service. Drain system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before partially or completely draining system. Minimize outage duration.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned ducts and piping to source of supply and/or main lines.

D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

H. Remove unused sections of supply and return air ductwork back to mains. Patch opening with sheet metal and seal airtight. Patch existing insulation to match existing. Where existing ductwork is to be capped and reused, locate the end cap within 6” of the last branch. End caps shall be 3” pressure class and seal class “A”.

I. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.4 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 23 05 29 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.
3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.6 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction or as noted on the drawings. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION
THIS PAGE IS LEFT BLANK
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single Phase and Three Phase Electric Motors.

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 05 00. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.

B. Submit shop drawings for all three phase motors.

C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.

D. Submit shaft grounding device for all motors as required.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer’s recommendations for equipment and motor.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

PART 2 - PRODUCTS

2.1 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

<table>
<thead>
<tr>
<th>Distribution/Nominal Voltage</th>
<th>Utilization Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>115</td>
</tr>
<tr>
<td>208</td>
<td>200</td>
</tr>
<tr>
<td>240</td>
<td>230</td>
</tr>
<tr>
<td>277</td>
<td>265</td>
</tr>
<tr>
<td>480</td>
<td>460</td>
</tr>
</tbody>
</table>
B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.

D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.

F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.

G. Each contractor shall set all motors furnished by him.

H. All motors shall have a minimum service factor of 1.15.

I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.

J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.

K. Aluminum end housings are not permitted on motors 15 HP or larger.

L. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.

M. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

N. Motor Construction: Open, drip-proof, NEMA Standard MG 1, general purpose, continuous duty, Design B, insulation class H.
2.2 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

A. All motors, unless exempted by EPAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

<table>
<thead>
<tr>
<th>HP</th>
<th>Full-Load Efficiencies %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open Drip-Proof (rpm)</td>
</tr>
<tr>
<td></td>
<td>1200</td>
</tr>
<tr>
<td>1.0</td>
<td>82.5</td>
</tr>
<tr>
<td>1.5</td>
<td>86.5</td>
</tr>
<tr>
<td>2.0</td>
<td>87.5</td>
</tr>
<tr>
<td>3.0</td>
<td>88.5</td>
</tr>
<tr>
<td>5.0</td>
<td>89.5</td>
</tr>
<tr>
<td>7.5</td>
<td>90.0</td>
</tr>
<tr>
<td>10.0</td>
<td>91.7</td>
</tr>
<tr>
<td>15.0</td>
<td>91.7</td>
</tr>
<tr>
<td>20.0</td>
<td>92.4</td>
</tr>
</tbody>
</table>

B. Motor nameplate shall be noted with the above ratings.

2.3 MOTORS ON VARIABLE FREQUENCY DRIVES

A. All motors driven by VFDs shall be premium efficiency type.

B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, “Performance Standards Applying to All Machines,” Part 31 “Definite-Purpose Inverter-Fed Polyphase Motors.

D. All 480-volt motors controlled by VFDs shall be equipped with an alternate discharge path, such as a shaft grounding ring or grounding brush, to divert adverse shaft currents from the motor bearings on the drive end of the motor shaft. Motor shafts 2” and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.

E. Motors will be designed to operate continuously at all speeds with variable speed drives having carrier frequency of 12 KHZ or higher without large fluctuations in amps drawn at any single speed.
A. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.

B. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer’s recommendations. Align shafts to manufacturer’s requirements or within 0.002 inch per inch diameter of coupling hub.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.
B. Equipment Bases and Supports.
C. Sleeves and Seals.
D. Flashing and Sealing of Equipment and Pipe Stacks.
E. Cutting of Openings.
F. Escutcheon Plates and Trim.

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

A. Refer to Section 23 05 50 for additional requirements for seismic restraints.

2.2 HANGER RODS

A. Hanger rods for single rod hangers shall conform to the following:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Hanger Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; and smaller</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; through 3-5/8&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>4&quot; and 5&quot;</td>
<td>5/8&quot;</td>
</tr>
</tbody>
</table>

Column #1: Steel pipe.
Column #2: Copper pipe.

B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.3 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).

2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
a. Insulation Couplings:

1) Insulation Coupling: Molded thermoplastic, -65ºF to 275ºF, sizes up to 4-1/8” OD, and receive insulation thickness up to 1”. Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60ºF, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.

2) Horizontal Strut Mounted Insulated Pipe:
   a) Acceptable Manufacturers: Klo-Shure or equal.

3) Vertical:
   a) Acceptable Manufacturers: Klo-Shure Titan or equal.

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

   Acceptable Products:
   Cooper/B-Line - Fig B3373 Series
   Erico - 510 Series
   Nibco/Tolco - Fig. 82

2. Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

   Acceptable Products: Mason RBA, RCA, or BR.

3. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.

4. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.

2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65ºF to +275ºF.
On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.

Ferrous hot piping 2-1/2 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

Acceptable Products:

- **Anvil** - Fig. 160, 161, 162, 163, 164, 165
- **Cooper/B-Line** - Fig. 3160, 3161, 3162, 3163, 3164, 3165
- **Erico** - Model 630, 631, 632, 633, 634, 635
- **Nibco/Tolco** - Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4

As an alternative to separate pipe insulation insert and saddle, properly sized integral rigid insulation sections may be used.

Acceptable Products:

- **Cooper/B-Line** - Fig. B3380 through B3384
- **Pipe Shields** - A1000, A2000
- **Erico** - Model 124, 127

Unless otherwise indicated, hangers shall be as follows:

a. **Clevis Type:**
   - **Service:** Bare Metal Pipe
   - **Insulated Cold Pipe**
   - **Insulated Hot Pipe - 3 inches & Smaller**

   Acceptable Products:

<table>
<thead>
<tr>
<th>Service</th>
<th>Bare Steel or Insulated Pipe</th>
<th>Bare Copper Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anvil</strong></td>
<td>Fig. 260</td>
<td></td>
</tr>
<tr>
<td><strong>Cooper/B-Line</strong></td>
<td>Fig. 3100</td>
<td>Fig. B3100C</td>
</tr>
<tr>
<td><strong>Erico</strong></td>
<td>Model 400</td>
<td></td>
</tr>
<tr>
<td><strong>Nibco/Tolco</strong></td>
<td>Fig. 1</td>
<td>Fig. 81PVC</td>
</tr>
</tbody>
</table>

b. **Roller Type:**
   - **Service:** Insulated Hot Pipe - 4 inches and Larger

   Acceptable Products: 4" through 6"

<table>
<thead>
<tr>
<th>Service</th>
<th>Bare Steel or Insulated Pipe</th>
<th>Bare Copper Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anvil</strong></td>
<td>Fig. 181, 271</td>
<td></td>
</tr>
<tr>
<td><strong>Cooper/B-Line</strong></td>
<td>Fig. 3110, 3117</td>
<td></td>
</tr>
<tr>
<td><strong>Erico</strong></td>
<td>Model 610</td>
<td></td>
</tr>
<tr>
<td><strong>Nibco/Tolco</strong></td>
<td>Fig. 324, 327</td>
<td></td>
</tr>
</tbody>
</table>

c. **Continuous Channel with Clevis Type:**
   - **Service:** Plastic Tubing
   - **Flexible Hose**
   - **Soft Copper Tubing**

   Acceptable Products:
   Cooper/B-Line - Fig. B3106, with Fig. B3106V
   Erico - Model 104, with Model 104V
   Nibco/Tolco - Fig. 1V
d. **Adjustable Swivel Ring Type:**
   Service: Bare Metal Pipe - 4 inches and Smaller

<table>
<thead>
<tr>
<th>Acceptable Products</th>
<th>Bare Steel Pipe</th>
<th>Bare Copper Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvil</td>
<td>Fig. 69</td>
<td></td>
</tr>
<tr>
<td>Cooper/B-Line</td>
<td>Fig. B3170NF</td>
<td>Fig. B3170CTC</td>
</tr>
<tr>
<td>Erico</td>
<td>Model FCN</td>
<td>102A0 Series</td>
</tr>
<tr>
<td>Nibco/Tolco</td>
<td>Fig. 200</td>
<td>Fig. 203</td>
</tr>
</tbody>
</table>

7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer’s installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

   a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

   a. **Clamp Type:**
      Service: Bare Metal Pipe
      Insulated Cold Pipe
      Insulated Hot Pipe - 3 inches and smaller

      1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.

      2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.

<table>
<thead>
<tr>
<th>Acceptable Products</th>
<th>Bare Steel or Insulated Pipe</th>
<th>Bare Copper Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unistrut</td>
<td>Fig. P1100 or P2500</td>
<td></td>
</tr>
<tr>
<td>Cooper/B-Line</td>
<td>Fig. B2000 or B2400</td>
<td>Fig. BVT</td>
</tr>
<tr>
<td>Nibco/Tolco</td>
<td>Fig. A-14 or 2STR</td>
<td></td>
</tr>
</tbody>
</table>

   b. **Roller Type:**
      Service: Insulated Hot Pipe - 4 inches and larger.

<table>
<thead>
<tr>
<th>Acceptable Products</th>
<th>4&quot; through 6&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unistrut</td>
<td>Fig. P2474</td>
</tr>
<tr>
<td>Cooper/B-Line</td>
<td>Fig. B218</td>
</tr>
<tr>
<td>Nibco/Tolco</td>
<td>Fig. ROL-12</td>
</tr>
</tbody>
</table>
D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

   a. Steel Structure Clamps

      1) C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists):

         Acceptable Products:

         | Manufacturer      | Model   |
         |--------------------|---------|
         | Anvil              | Fig. 92 |
         | Cooper/B-Line      | B3033/B3034 |
         | Erico              | Model 300 |
         | Nibco/Tolco        | 68      |

      2) Scissor Type Beam Clamps (For use with bar-joists and wide flange):

         Acceptable Products:

         | Manufacturer      | Model   |
         |--------------------|---------|
         | Anvil              | Fig. 228, 292 |
         | Cooper/B-Line      | B3054  |
         | Erico              | Model 360 |
         | Nibco/Tolco        | Fig. 329 |

   b. Concrete

      1) Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

      2) Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

   c. Steel Structure Welding:

      1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.4 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Refer to Section 23 05 50 for additional requirements for concrete bases in seismic applications.

2. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).

3. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a “dirt-trap”.

4. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6”x6”, W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.

5. Equipment requiring bases is as follows:
   a. Air Handling Unit

C. Equipment Roof Support (Curbs and Rails):

1. Rooftop equipment such as packaged air handling units, roof hoods and rooftop exhaust fans shall be provided with curbs by the unit manufacturer.

2. Where not furnished with rooftop equipment, provide prefabricated curbs or rails as follows:
   a. 12” high above the top surface of the roof (not the roof structure).
   b. 14 or 18 gauge galvanized sheet metal, as required for the equipment weight.
   c. Internal reinforcing.
   d. Pressure treated wood nailer.
   e. 18 gauge counter flashing completely covering nailer.
   f. Factory insulated with rigid fiberglass.

3. Match units to the building roof with either a raised cant to match roof insulation (for built-up roofs), or with no cant (for single-ply roofs).

4. Where legs of equipment rest on rails, provide 1/4" bent plates 18" long.

5. Acceptable Manufacturers: Thy, Pate, United, Roof Products Systems or Portals Plus.

6. Equipment requiring curbs or rails is as follows:
   a. Air Handling Units
   b. Fans
D. Roof Pipe Supports:
1. Provide pre-fabricated roof pipe supports for all piping installed on the roof.
2. Support shall guide and align pipe while permitting longitudinal expansion.
3. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
4. Support shall be UV, corrosion and freeze/thaw resistant.
5. Support shall include orange paint, reflective safety orange accents or similar markings for increased visibility.
6. The strut system shall have a powder coated finish.
7. Acceptable Products: Anvil International HBS-Base Series, Cooper B-Line Dura-Blok, Erico Caddy Pyramid 50, 150, 300, or 600 (to match load), Miro Industries 1.5, 3-R, 4-R or 5-R (to match pipe).

E. Supports:
1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

F. Grout:
1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.5 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.6 ROOF PENETRATIONS

A. Seal pipes with surface temperature below 150ºF penetrating single-ply roofs with conical stepped pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots. Material shall match roofing membrane.

B. Break insulation only at the clamp for pipes between 60ºF and 150ºF. Seal outdoor insulation edges watertight.

2.7 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor’s work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1” above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer’s design.

F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4” resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.8 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.9 PIPE PENETRATIONS
A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.10 PIPE ANCHORS
A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.11 FINISH
A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION
3.1 HVAC SUPPORTS AND ANCHORS
A. General Installation Requirements:
1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.
B. Supports Requirements:
1. Install roof pipe supports to resist wind movement per manufacturer’s recommendations. Method of securing base to roof shall be compatible with roofing materials.
2. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
3. Set all concrete inserts in place before pouring concrete.
4. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.

5. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.

6. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.

4. Piping shall not introduce strains or distortion to connected equipment.

5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.

6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.

7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.

8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3’ spacing between loads.

2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
   a. The hanger is attached within 6” from a web/chord joint.
   b. Additional L2x2x1/4 web reinforcement is installed per manufacturer’s requirements.

3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.

4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Spacing of Hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Steel and Fiberglass (Std. Weight or Heavier – Liquid Service):</td>
<td></td>
</tr>
<tr>
<td>1-1/4&quot; &amp; under</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>2&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>2-1/2&quot;</td>
<td>11'-0&quot;</td>
</tr>
<tr>
<td>3&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>4&quot; &amp; larger</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>2. Steel (Std. Weight or Heavier – Vapor Service):</td>
<td></td>
</tr>
<tr>
<td>1-1/4&quot; and under</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>2&quot; &amp; larger</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>3. Hard Drawn Copper &amp; Brass (Liquid Service):</td>
<td></td>
</tr>
<tr>
<td>3/4&quot; and under</td>
<td>5'-0&quot;</td>
</tr>
<tr>
<td>1&quot;</td>
<td>6'-0&quot;</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>8'-0&quot;</td>
</tr>
<tr>
<td>2&quot;</td>
<td>8'-0&quot;</td>
</tr>
<tr>
<td>2-1/2&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>3&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>4&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>6&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>4. Hard Drawn Copper &amp; Brass (Vapor Service):</td>
<td></td>
</tr>
<tr>
<td>3/4&quot; &amp; under</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>1&quot;</td>
<td>8'-0&quot;</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>2&quot;</td>
<td>11'-0&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; &amp; larger</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>5. Flexible Plastic Pipe, Flexible Hose, and Soft Copper Tubing:</td>
<td></td>
</tr>
<tr>
<td>a. Continuous channel with hangers maximum 8'-0&quot; OC.</td>
<td></td>
</tr>
</tbody>
</table>
6. Rigid Plastic Pipe:
   a. Hangers shall be spaced based on the piping system manufacturers' instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

7. Installation of hangers shall conform to MSS SP-58, 69, and 89.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Bases.
B. Vibration Isolation.
C. Flexible Connectors.

1.2 SUBMITTALS

A. Submit shop drawings per Division 1 and the Vibration Isolation Submittal Form at the end of this section.
B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.
C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.
D. Isolator submittals shall include:
   1. Equipment served
   2. Type of Isolator
   3. Load in Pounds per Isolator
   4. Recommended Maximum Load for Isolator
   5. Spring Constants of Isolators (for Spring Isolators)
   6. Load vs. Deflection Curves (for Neoprene Isolators)
   7. Specified Deflection
   8. Deflection to Solid (at least 150% of calculated deflection)
   9. Loaded (Operating) Deflection
   10. Free Height
   11. Loaded Height
   12. Kx/Ky (horizontal to vertical stiffness ratio – for spring isolators)
   13. Materials and Coatings
   14. Spring Diameters
E. Make separate calculations for each isolator on equipment where the load is not equally distributed.
F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.
G. Submit certification that equipment, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:
   1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 BASIC CONSTRUCTION AND REQUIREMENT

A. Vibration isolation for this project is subject to seismic restraint requirements of Section 23 05 50.

B. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

C. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection [e.g., 3" for 2" calculated deflection]. The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

D. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

E. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

F. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

G. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.

H. Provide motor slide rails for belt-driven equipment per Section 23 05 13.

I. All isolators, except M1, shall have provision for leveling.

2.2 MOUNTINGS

A. Type M2:

1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.

2. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.

3. All units shall have bolt holes and be bolted down.
4. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.


2.3 THRUST RESTRAINTS

A. Type TR1:

1. Horizontal thrust restraints shall consist of spring elements in neoprene cups with grommets to prevent short circuiting hanger rods and nuts and washers for pre-compression.

2. Select springs for deflection of 0.75" to 1.50" at maximum calculated thrust. Springs shall be field adjusted for 1/2" movement. Spring constant may not exceed 50% of the vertical stiffness of the mounts (M3, etc.).

3. Centrifugal fans shall incline slightly forward when off and discharge directly in line with the ductwork at maximum static pressure.

4. Fabricate structural supports as needed to attach thrust restraints.

5. If connected to a housing, check maximum thrust the housing can restrain and connections required.


2.4 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.

2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.

3. Provide hangers with end connections as required for hanging ductwork or piping.


B. Type H2:

1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.

2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30º arc before contacting the grommet and short circuits the spring.

4. Provide end connections for hanging ductwork or piping.


2.5 BASES

A. Type B1:

1. Rectangular structural steel bases.

2. All perimeter members shall be beams or channels with minimum depth of 10% of the longest base dimension or 14” maximum if rigidity is acceptable to the equipment manufacturer.

3. Use height saving brackets, unless noted otherwise.


2.6 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

A. Type FC1:

1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.

2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.

3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.

4. Connectors up to 2" size may have threaded ends.

5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.

6. All connectors shall be rated for a minimum working pressure of 150 psi at 200ºF.


B. Type FC2:

1. Stainless steel flexible connectors with corrugated stainless steel hose body and stainless steel braided casing.

2. Rated for minimum working pressures of 150 psi at 70ºF and 100 psi at 800ºF.

3. Sizes 2" and under shall have steel threaded connections.
4. Sizes 2-1/2" and over shall have 150 lb. steel flanges.

5. Suitable for 1/2" permanent misalignment.


2.7 VIBRATION ISOLATION CURBS

A. Spring Isolated Curbs:

1. Provide factory fabricated vibration isolated curb consisting of an upper floating section resting on a rigid rectangular steel tube structure containing adjustable steel vibration isolation springs.

2. The top of the curb shall be a minimum of 20" above the roof surface.

3. Vibration Isolation:

   a. Isolators shall consist of free standing, unhoused laterally stable steel springs.

   b. Springs shall be zinc electroplated.

   c. Springs shall rest on a minimum of 1/4" neoprene pad.

   d. Springs shall provide a minimum of 1-1/2" deflection calculated based on final assembled loads.

4. Provide continuous wood nailing strip and counter flashing along entire perimeter of the curb.

5. Provide continuous air and water seal, such as an EPDM bellows, around the entire curb.

6. Curb assembly shall withstand 125#/sf lateral wind loading against the supported equipment.

7. The curb shall be designed with lateral restraint to meet seismic requirements specified in Section 23 05 50.

8. Coordinate internal structural cross framing with ductwork and piping routed in the curb.


PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install all products per manufacturer’s recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.
C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

3.2 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. For base mounted pumps without resilient mountings, the first five hangers shall be Type H1.

C. Where piping is floor-supported, use M2 instead of H1 and M3 instead of H2.

D. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.

E. Use Type FC1 where pressures are lower than 150 psi, temperatures are below 220°F, and the fluid handled is compatible with neoprene and EPDM.

F. Use Type FC2 for all other services. FC2 shall be installed parallel with equipment shafts.

G. Provide sufficient piping flexibility for vibrating refrigerant equipment or furnish flexible connectors with appropriate temperature and pressure ratings.

H. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.

I. Support piping to prevent extension of flexible connectors.

3.3 VIBRATION ISOLATION OF DUCTWORK

A. The first three hangers on all fan systems shall be Type H1 with at least 0.20” minimum static deflection.

B. Provide flexible duct connections as described in Section 23 33 00 at all fan inlets and outlets and on the mechanical room side of all locations where ducts penetrate mechanical room walls.
### 3.4 VIBRATION ISOLATION SCHEDULE

<table>
<thead>
<tr>
<th>EQUIPMENT DESIGNATION</th>
<th>BASE TYPE</th>
<th>ISOLATOR TYPE</th>
<th>STATIC DEFLECTION</th>
<th>FLEXIBLE CONNECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief Fan</td>
<td>NA</td>
<td>M3 or H2 or H3</td>
<td>0.75&quot; 1.5&quot;</td>
<td>NA</td>
</tr>
</tbody>
</table>

Note 1: AHU internal fan isolation shall be determined by AHU manufacturer. Isolation selected shall be a minimum of 98% efficient at scheduled CFM and static pressure.

END OF SECTION
<table>
<thead>
<tr>
<th>COLUMN 1</th>
<th>PROPOSED ISOLATOR</th>
<th>CALCULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITEM SERVED</td>
<td>MIN DEFL (*)</td>
<td>MIN DEFL (*)</td>
</tr>
<tr>
<td>Note numbers correspond to the column numbers above.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Item served should match designation on the design drawings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. List the deflection scheduled or specified in the design documents.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. List the manufacturer's complete model designation for the isolator.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. List the manufacturer's maximum rated load for the isolator.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. List the isolator deflection at the maximum rated load in column 5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GENERAL NOTES:
1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Seismic Requirements.

1.2 QUALITY ASSURANCE

A. General:

1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.

2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for seismic restraint.

3. These requirements are beyond those listed in Section 23 05 29 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.

2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

C. Testing Agency: An independent testing agency, acceptable to Authorities Having Jurisdiction, with experience and capability to conduct the testing indicated.

D. Installer: Company specializing in performing the work of this Section.

E. Suppliers: Following is a partial list of manufacturer/supplier contact information for seismic restraints:

2. Unistrut Corporation http://www.unistrut.us/
7. ISAT 877.523.6060, www.isatsb.com

1.3 SUBMITTALS

A. Submit under provisions of Division 1.
B. Submittal to Code Official

1. Contractor shall submit copies of the seismic shop drawings to the governing code authority for approval.

C. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located experienced in seismic restraint design and installation.

2. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.

3. Manufacturer’s Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer’s certifications of compliance.

4. System Supports/Restraints - Submit for each condition requiring seismic bracing:
   a. Calculations for each seismic brace and detail utilized on the project.
   b. Plan drawings showing locations and types of seismic braces on contractor fabrication/installation drawings.
   c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
   d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Equipment - Submit for each piece of equipment supplied:
   a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
   b. Specific details of seismic design features of equipment and maximum seismic loads imparted to the structural support.
   c. Engineering calculations and details for equipment anchorage and support structure.

D. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance to the exception.
1.4 TESTING AND INSPECTION

A. Special Inspection and Testing shall be done in accordance with Chapter 17 of the International Building Code.

B. The Contractor shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency’s knowledge, in conformance with the approved plans and specifications shall be submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer’s instructions for storage.

1.6 DESIGN REQUIREMENTS

A. This project is subject to the seismic bracing requirements of the International Building Code, 2018 edition.

B. The following criteria are applicable to this project:

1. Risk Category: IV
2. Seismic Factor: \( I_E = 1.5 \)
3. Seismic Design Category: D
4. Component Amplification Factors (\( a_c \)) and Component Response Modification Factors (\( R_p \)) shall be taken from Table 13.5-1 in ASCE 7-16 for the individual equipment or system being restrained.
5. Component Importance Factors (\( I_p \)) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
6. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

C. Forces shall be calculated with the above requirements and Equation 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4
D. Equipment shall meet International Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

E. All seismic anchorage and bracing shall comply with FM Global Property Loss Prevention Data Sheet 1-11, Fire Following Earthquakes.

1.7 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

1.8 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SEISMIC DESIGN CRITERIA

A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.

B. Definitions

1. Stay in Place:
   a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2. Remain Operational:
   a. Requirements for “Stay in Place” listed above shall be met.
   b. The following systems and associated equipment are intended not to fail externally or internally and are intended to remain operational.

   1) Fire Protection
   2) Heating
   3) Cooling
   4) Humidification
   5) Air Handling
   6) Exhaust

2.2 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record; refer to submittal requirements.
2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer’s submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.

3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.

4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.

5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code.

6. All seismic restraints and combination isolator/restraints shall have verification of their seismic capabilities witnessed by an independent testing agency.

B. Friction from gravity loads shall not be considered resistance to seismic forces.

C. Housekeeping Pads:
   1. Reinforced housekeeping pads shall be provided to handle shear, tension, and compression forces with proper reinforcement, doweling, and attachments connecting the pad to the structural slab.

2.3 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.

B. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

   1. Air Handling Units

2.4 MATERIALS

A. Use the following materials for restraints:

   1. Indoor Dry Locations: Steel, zinc plated.
   2. Outdoors and Damp Locations: Galvanized steel.

2.5 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.

   1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.

C. Concrete Inserts: Steel-channel type.
D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM F3125, Grade A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.6 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch-thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.


3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.

4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.

B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.

C. All rigid floor mounted equipment shall have a resilient media between the equipment mounting hole and the anchor bolt in concrete.

D. All seismic restraint systems shall be installed in strict accordance with the manufacturer’s written instructions and all certified submittal data.

E. Installation of seismic restraints shall not cause any change in position of equipment, piping, or ductwork, resulting in stresses or misalignment.
F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

G. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.

H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect/Engineer’s attention prior to specific equipment selection.

I. Prior to installation, bring to the Architect/Engineer’s attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.

K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.

L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

M. Do not install cables over sharp corners.

N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

O. Provide reinforced clevis bolts when required.

P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

Q. Post-Installed anchors shall be provided to meet seismic requirements.

R. Vertical pipe risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.

S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

T. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.

U. Water tanks shall be secured to their saddles by welding or proper concrete attachment, and those saddles shall be properly attached to the structure.

V. Brace all terminal units with water coils as required by the building code and provide flexible connection to the coil if bracing is required.
W. Independently brace duct mounted equipment (terminal units, in-line fans, etc.) and the associated suspended ductwork.

X. Do not brace a system to two different structures such as a wall and a ceiling.

Y. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

Z. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

AA. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.

BB. Coordinate seismic bracing of architecturally exposed ductwork with the Architect/Engineer.

3.2 SEISMIC RESTRAINT EXCLUSIONS

A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Identification of products installed under Division 23.

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 05 00. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS


2.2 MATERIALS

A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<table>
<thead>
<tr>
<th>OD of Pipe or insulation</th>
<th>Marker Length</th>
<th>Size of Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 1-1/4&quot;</td>
<td>8&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>1-1/2&quot; to 2&quot;</td>
<td>8&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; to 6&quot;</td>
<td>12&quot;</td>
<td>1-1/4&quot;</td>
</tr>
</tbody>
</table>

Plastic tags may be used for outside diameters under 3/4".

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

I. Ductwork Markers:
   1. Ductwork systems containing hazardous materials shall be provided with minimum 2”x4” ANSI Z535.2 biohazard warning labels with custom labeling describing hazard. Refer to table in Part 3 for system and label description.
   2. Vinyl Markers: Colored vinyl with permanent pressure sensitive adhesive backing suitable for indoor and outdoor application.

J. Maintenance Access Doors:
   1. Doors and roof hatches used to access equipment serving hazardous ductwork systems shall be provided with a minimum 4”x6” ANSI Z535.2 biohazard warning label. Label shall read “WARNING – BIOHAZARD. ONLY AUTHORIZED PERSONNEL BEYOND THIS POINT”.
   2. Coordinate location of warning label with Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturer’s recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:
   1. All valves (except shutoff valves at equipment) shall have numbered tags.
   2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
   3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
   4. Secure tags with heavy duty key chain and brass “S” link or with mechanically fastened plastic straps.
   5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
   6. Number all tags and show the service of the pipe.
   7. Provide two sets of laminated 8-1/2” x 11” copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.
D. **Pipe Markers:**

1. **Adhesive Backed Markers:** Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.

2. **Snap-on Markers:** Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.

3. **Stencil Painted Pipe Markers:**
   a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
   b. Apply primer on non-insulated pipes before painting.
   c. Use background and letter colors as scheduled later in this section.

4. **Apply markers and arrows in the following locations where clearly visible:**
   a. At each valve.
   b. On both sides of walls that pipes penetrate.
   c. At least every 20 feet along all pipes.
   d. On each riser and each leg of each "T" joint.
   e. At least once in every room and each story traversed.

E. **Ductwork Markers:**

1. **Apply ductwork markers on ductwork systems containing hazardous materials in the following locations where clearly visible:**
   a. On both sides of walls that ducts penetrate.
   b. At least every 20 feet along all ducts.
   c. On each riser and each leg of each branch connection.
   d. At least once in every room and each story traversed.
   e. At all ductwork access doors.
   f. At all fans and equipment serving ductwork system. Markers shall be clearly visible from the normal maintenance access path to the equipment. Coordinate placement location with Owner.

F. **Equipment:**

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.

2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.

3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.
G. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.

2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with the text as shown in the following table regardless of which method or material is used:

<table>
<thead>
<tr>
<th>Pipe Service</th>
<th>Lettering Color</th>
<th>Background Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEAM - 90 PSI</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>STEAM - 60 PSI</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>STEAM - 30 PSI</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>STEAM - 15 PSI</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>STEAM - 5 PSI</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>CLEAN STEAM - 0 PSI</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>HEATING WATER SUPPLY</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>HEATING WATER RETURN</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>HIGH PRESSURE CONDENSATE</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>MEDIUM PRESSURE CONDENSATE</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>LOW PRESSURE CONDENSATE</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>PUMPED CONDENSATE</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>CHILLED WATER SUPPLY</td>
<td>White</td>
<td>Green</td>
</tr>
<tr>
<td>CHILLED WATER RETURN</td>
<td>White</td>
<td>Green</td>
</tr>
<tr>
<td>CONDENSATE DRAIN</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>COMPRESSED AIR</td>
<td>Black</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

B. Steam pipe markers shall include operating steam pressure within pipes shown in table above.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of hydronic and steam systems.
C. Adjusting total HVAC systems to provide indicated quantities.
D. Measurement of final operating condition of HVAC systems.
E. Setting quantitative performance of HVAC equipment.
F. Sound measurement of equipment operating conditions.
G. Vibration measurement of equipment operating conditions.
H. Verify that automatic control devices are functioning properly.
I. Reporting results of the activities and procedures specified in this section.

1.02 REFERENCES

A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council.

1.03 SUBMITTALS

A. Final Reports - Include following information in report:
   1. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   2. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
   4. Provide four (4) copies of reports in 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
   5. Air Data: Include design and actual values for the following:
      a. Average entering air, dry-bulb and wet-bulb, temperature in degrees Fahrenheit.
      b. Average leaving air, dry-bulb and wet-bulb, temperature in degrees Fahrenheit.
      c. Ambient temperature, dry-bulb and wet-bulb, in degrees Fahrenheit.
   6. Steam Test Data:
      a. Include design and actual values for inlet pressure in psig and temperature in degrees Fahrenheit.
   7. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
   8. Test Reports: Indicate data on AABC MN-1 forms.
9. Include the following in each report:
   a. Title Page.
   b. Name, address and telephone number of Testing, Adjusting, and Balancing Agency.
   c. Project name.
   d. Project number.
   e. Project location.
   f. Project Engineer name and address.
   g. Project Contractor name and address.
   h. Report date.
   i. Signature of testing, adjusting, and balancing agent who certifies the report.
   j. Summary of contents, including the following:
      1) Design versus final performance.
      2) Notable characteristics of systems.
      3) Description of system operation sequence if it varies from the Contract Documents.
   k. Nomenclature sheets for each item of equipment.
   l. Notes to explain why certain final data in the body of reports vary from design values.
   m. Fan curves.
   n. Manufacturer's test data.
   o. Field test reports prepared by system and equipment installers.
   p. Other information relative to equipment performance, but do not include approved shop drawings or product data.

B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.04 QUALITY ASSURANCE
A. Perform total system balance in accordance with AABC MN-1.
   1. Maintain one copy of each document on site.
B. TAB Agency Qualifications: Company specializing in the testing, adjusting, and balancing of systems specified in this Section certified by AABC and NEBB.
C. Perform Work under supervision of AABC Certified Test and Balance Engineer experienced in performance of this Work and licensed at the University of Missouri - Columbia.

1.05 PRE-BALANCING MEETING
A. Convene a meeting one week prior to commencing work of this Section. Coordinate meeting with Owner's Representative.
B. Provide seven (7) days advance notice for each test. Include scheduled test dates and times.

1.06 SEQUENCING AND SCHEDULING
A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.
B. Schedule and provide assistance in final adjustment and test of life safety system, smoke evacuation system, and smoke control system with Fire Authority.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine contract documents to become familiar with project requirements. Contract Documents are defined in the General and Special Conditions of the Contract.
B. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable. Calibration and commissioning are part of this scope.
3. Proper thermal overload protection is in place for electrical equipment.
4. Verify free travel and proper operation of control devices such as damper and valve operators.
5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
6. Duct systems are clean of debris.
7. Fans are rotating correctly.
8. Fire and volume dampers are in place and open.
9. Air coil fins are cleaned and combed.
10. Balancing devices are properly installed and locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
11. Access doors are closed and duct end caps are in place.
12. Air outlets are installed and connected.
13. Duct system leakage is minimized.
14. Hydronic systems are flushed, filled, and vented.
15. Pumps are rotating correctly.
16. Proper strainer baskets are clean and in place.
17. Service and balance valves are open.

C. Examine approved submitted data of HVAC systems and equipment.

D. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance to the Owner's Representative.

E. Beginning of work means acceptance of existing conditions.

3.02 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

C. Prepare a testing, adjusting and balancing plan that includes strategies and step-by-step procedures.

3.03 INSTALLATION TOLERANCES

A. Air Handling Units: Adjust to within plus 5 to 0 percent.

B. Exhaust Fans: Adjust total to within plus 5 to 0 percent.

C. Hydronic Systems: Adjust to within plus 5 to minus 5 percent of design.

3.04 GENERAL TESTING AND BALANCING PROCEDURES

A. Cut insulation, ducts, pipes and equipment cabinets of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this project.

B. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
3.05 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.
B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
F. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
C. Measure air quantities at air inlets and outlets.
D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
L. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
N. On fan powered VAV boxes, adjust air flow switches for proper operation.
3.07 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. Fire Pumps
   2. Sprinkler Air Compressor
   3. Electric Water Coolers
   4. Plumbing Pumps
   5. Steam Condensate Pumps
   6. HVAC Pumps
   7. Forced Air Furnaces
   8. Packaged Roof Top Heating/Cooling Units
   9. Packaged Terminal Air Conditioning Units
  10. Unit Air Conditioners
  11. Computer Room Air Conditioning Units
  12. Air Coils
  13. Terminal Heat Transfer Units
  14. Air Handling Units
  15. Fans
  16. Air Filters
  17. Air Terminal Units
  18. Air Inlets and Outlets
  19. Controls Compressor

B. Report:
   1. Summary Comments:
      a. Design versus final performance
      b. Notable characteristics of system
      c. Description of systems operation sequence
      d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
      e. Nomenclature used throughout report
      f. Test conditions

   2. Instrument List:
      a. Instrument
      b. Manufacturer
      c. Model number
      d. Serial number
      e. Range
      f. Calibration date
C. Electric Motors:
1. Manufacturer
2. Model/Frame
3. HP/BHP
4. Phase, voltage, amperage; nameplate, actual, no load
5. RPM
6. Service factor
7. Starter size, rating, heater elements
8. Sheave Make/Size/Bore

D. V-Belt Drives:
1. Identification/location
2. Required driven RPM
3. Driven sheave, diameter and RPM
4. Belt, size and quantity
5. Motor sheave diameter and RPM
6. Center to center distance, maximum, minimum, and actual

E. Pumps:
1. Identification/number
2. Manufacturer
3. Size/model
4. Impeller
5. Service
6. Design flow rate, pressure drop, BHP
7. Actual flow rate, pressure drop, BHP
8. Discharge pressure
9. Suction pressure
10. Total operating head pressure
11. Shut off, discharge and suction pressures
12. Shut off, total head pressure

F. Cooling Tower:
1. Tower identification/number
2. Manufacturer
3. Model number
4. Serial number
5. Rated capacity
6. Entering air WB temperature, specified and actual
7. Leaving air WB temperature, specified and actual
8. Ambient air DB temperature
9. Condenser water entering temperature
10. Condenser water leaving temperature
11. Condenser water flow rate
12. Fan RPM

G. Heat Exchangers:
1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Model number
6. Serial number
7. Steam pressure, design and actual
8. Primary water entering temperature, design and actual
9. Primary water leaving temperature, design and actual
10. Primary water flow, design and actual
11. Primary water pressure drop, design and actual
12. Secondary water leaving temperature, design and actual
13. Secondary water leaving temperature, design and actual
14. Secondary water flow, design and actual
15. Secondary water pressure drop, design and actual

H. Cooling Coils:
1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Entering air DB temperature, design and actual
7. Entering air WB temperature, design and actual
8. Leaving air DB temperature, design and actual
9. Leaving air WB temperature, design and actual
10. Water flow, design and actual
11. Water pressure drop, design and actual
12. Entering water temperature, design and actual
13. Leaving water temperature, design and actual
14. Saturated suction temperature, design and actual
15. Air pressure drop, design and actual

I. Heating Coils:
1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Water flow, design and actual
7. Water pressure drop, design and actual
8. Entering water temperature, design and actual
9. Leaving water temperature, design and actual
10. Entering air temperature, design and actual
11. Leaving air temperature, design and actual
12. Air pressure drop, design and actual

J. Electric Duct Heaters:
1. Manufacturer
2. Identification/number
3. Location
4. Model number
5. Design kW
6. Number of stages
7. Phase, voltage, amperage
8. Test voltage (each phase)
9. Test amperage (each phase)
10. Air flow, specified and actual
11. Temperature rise, specified and actual

K. Fresh Air Heat Pump Dehumidification Equipment:
1. Manufacturer
2. Identification/number
3. Location
4. Model number
5. Size
6. Design air flow and actual air flow
7. Outdoor air temperature (dry-bulb and wet-bulb)
8. Cooling coil (pressure and temperature change across the coil)
9. Heating coil (pressure and temperature change across the coil)
10. Supply air temperature (dry-bulb and wet-bulb)
11. Sheave Make/Size/Bore
12. Number of Belts/Make/Size
13. Fan RPM

L. Air Moving Equipment:
   1. Identification / Location
   2. Manufacturer
   3. Model number
   4. Serial number
   5. Arrangement/Class/Discharge
   6. Air flow, specified and actual
   7. Return air flow, specified and actual
   8. Outside air flow, specified and actual
   9. Total static pressure (total external), specified and actual
   10. Inlet pressure
   11. Discharge pressure
   12. Sheave Make/Size/Bore
   13. Number of Belts/Make/Size
   14. Fan RPM
   15. Return air temperature
   16. Outside air temperature
   17. Required mixed air temperature
   18. Actual mixed air temperature
   19. Design outside/return air ratio
   20. Actual outside/return air ratio

M. Exhaust Fans:
   1. Location
   2. Manufacturer
   3. Model number
   4. Serial number
   5. Air flow, specified and actual
   6. Total static pressure (total external), specified and actual
   7. Inlet pressure
   8. Discharge pressure
   9. Sheave Make/Size/Bore
   10. Number of Belts/Make/Size
   11. Fan RPM

N. Duct Traverses:
   1. System zone/branch
   2. Duct size
   3. Area
   4. Design velocity
   5. Design air flow
   6. Test velocity
   7. Test air flow
   8. Duct static pressure
   9. Air temperature
   10. Air correction factor
O. Duct Leak Tests:
   1. Description of ductwork under test
   2. Duct design operating pressure
   3. Duct design test static pressure
   4. Duct capacity, air flow
   5. Maximum allowable leakage duct capacity times leak factor
   6. Test apparatus
      a. Blower
      b. Orifice, tube size
      c. Orifice size
      d. Calibrated
   7. Test static pressure
   8. Test orifice differential pressure
   9. Leakage

P. Air Monitoring Stations:
   1. Identification/location
   2. System
   3. Size
   4. Area
   5. Design velocity
   6. Design air flow
   7. Test velocity
   8. Test air flow

Q. Flow Measuring Stations:
   1. Identification/number
   2. Location
   3. Size
   4. Manufacturer
   5. Model number
   6. Serial number
   7. Design Flow rate
   8. Design pressure drop
   9. Actual/final pressure drop
   10. Actual/final flow rate
   11. Station calibrated setting

R. Terminal Unit Data:
   1. Manufacturer
   2. Type, constant, variable, single, dual duct
   3. Identification/number
   4. Location
   5. Model number
   6. Size
   7. Minimum static pressure
   8. Minimum design air flow
   9. Maximum design air flow
   10. Maximum actual air flow
   11. Inlet static pressure

S. Air Distribution Tests:
   1. Air terminal number
   2. Room number/location
   3. Terminal type
   4. Terminal size
5. Area factor  
6. Design velocity  
7. Design air flow  
8. Test (final) velocity  
9. Test (final) air flow  
10. Percent of design air flow  

T. Sound Level Reports:  
1. Location  
2. Octave bands - equipment off  
3. Octave bands - equipment on  

U. Vibration Tests:  
1. Location of points:  
   a. Fan bearing, drive end  
   b. Fan bearing, opposite end  
   c. Motor bearing, center (if applicable)  
   d. Motor bearing, drive end  
   e. Motor bearing, opposite end  
   f. Casing (bottom or top)  
   g. Casing (side)  
   h. Duct after flexible connection (discharge)  
   i. Duct after flexible connection (suction)  
2. Test readings:  
   a. Horizontal, velocity and displacement  
   b. Vertical, velocity and displacement  
   c. Axial, velocity and displacement  
3. Normally acceptable readings, velocity and acceleration  
4. Unusual conditions at time of test  
5. Vibration source (if non-complying)  

END OF SECTION
SECTION 23 07 13
DUCTWORK INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ductwork Insulation.
B. Insulation Jackets.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer’s certificate indicating qualifications.

B. Materials: UL listed in Category HNKT; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723.

C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.3 SUBMITTALS

A. Submit shop drawings per Division 1. Include product description, list of materials and thickness for each service, and location.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both “Out of Package” and “Installed-Compressed 25%” K and R-values.

B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum ‘K’ value at 75°F; foil scrim Kraft facing, 3 lb./cu. ft. density.

2.2 JACKETS


2.3 JACKET COVERINGS

A. Stainless Steel Jackets: Type 304 stainless steel; 0.010” thick; smooth finish with Z edge seams and stainless steel bands for outdoor use.

B. Laminated 5 ply, flexible, self-adhering, protective jacketing, vapor barrier and weather proofing membrane having high performance acrylic adhesive capable of installation with no additional mechanical attachment. Owner/Architect shall select from manufacturer’s standard finishes. For areas exposed to high traffic or rough service, where scheduled or where shown on the drawings, use 13 ply heavy duty protective jacketing.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.

B. Install materials after ductwork has been tested.

C. Clean surfaces for adhesives.

D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.

E. Exterior Duct Wrap - Flexible, Type A:

1. Apply with edges tightly butted.

2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.

3. Seal joints with adhesive backed tape.

4. Apply so insulation conforms uniformly and firmly to duct.

5. Provide high-density insulation inserts at trapeze duct hangers and straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.

6. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.

7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.

8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.

9. Staples may be used but must be covered with tape.

10. Vapor barrier must be continuous.

11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

F. Semi Rigid Fiberglass Board Wrap - Type B (Indoor Use):

1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.

2. Space pins as needed to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.

4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.

G. Semi Rigid Fiberglass Board Wrap - Type B (Outdoor Use):
   1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
   2. Space pins as required to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
   3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of the same facing tape with adhesive.
   4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.
   5. Install vapor barrier jacket. Cover with stainless steel jacket covering with seams on the bottom of horizontal ductwork.
   6. Seal all butt joints with metal draw bands screwed to jacket and filled with sealant. Seal all joints watertight.
   7. Provide positive slope on top of all horizontal surfaces to prevent ponding of water.

H. Exterior Duct Wrap – Type I:
   1. On ducts with any sides having a dimension 20" and greater: Impale insulation on spindle anchors welded or mechanically fastened to the duct and secured with speed clips. Clip pins off close to speed clips. Adhesive or glue fastened anchors are not acceptable. Maximum anchor spacing per SMACNA Duct Construction Standards or manufacturer's recommendations, whichever is more restrictive. Locate pins within 4" from edges and at intervals not over 16" in all directions. Pins shall be long enough to prevent compressing the insulation.

I. Continue insulation with vapor barrier through penetrations unless code prohibits.

J. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

K. At connections to equipment such as VAV boxes, all collars, reheat coils, coil return bends shall be insulated as the adjacent duct. All components in contact with 55F supply air shall be insulated and a vapor barrier installed.

L. Repair damaged sections of existing mechanical insulation, damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

M. Do not cover the damper shafts and handles with insulation.
3.2 SCHEDULE

A. Refer to Section 23 31 00 for scheduling of insulation.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping Insulation.
B. Insulation Jackets.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in piping insulation application with five years minimum experience.
B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

1.3 SUBMITTALS

A. Submit shop drawings per Division 1. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 INSULATION

A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All purpose, white Kraft jacket bonded to aluminum foil and reinforced with fiberglass yarn, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
B. Type B: EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.
C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.35 maximum 'K' value at 75°F; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose white Kraft jacket for above grade installations.

2.2 VAPOR BARRIER JACKETS


2.3 JACKET COVERINGS

A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.
B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.030” thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40ºF to 150ºF. 25/50 maximum flame spread/smoke developed.

2.4 REMOVABLE INSULATION JACKETS

A. Removable insulation jackets shall consist of outer covering, interstitial insulation material, and inner covering.

B. Inner and outer covering shall be constructed from a minimum 16.5 oz./yd² PTFE fiberglass composite and suitable for insulating surface temperatures up to 550ºF.

C. Interstitial insulation blanket shall be minimum 1-1/2” thick and shall consist of either:
   1. Silica and glass-fiber insulation felts and blankets – minimum 6 lb./ft³ density.
   2. E-type glass-fiber felts and blankets – minimum 6 lb./ft³ density.

D. Construction: Inner and outer covering with interstitial insulation material shall be joined into a single assembly using a double sewn lock stitch with 4-6 stitches/inch. The thread used shall be able to withstand minimum 550ºF surface temperatures without degradation. The use of hog rings, staples, and wires for closure of assembly are not acceptable. The interstitial insulation shall be sewn as an integral part of the inner and outer coverings to prevent shifting of the insulation. Insulation pins are not an allowable method of preventing the insulation from shifting and shall not be used.

E. No raw cut jacket edges shall be exposed.

F. Jackets shall be fastened to equipment and piping components using hook and loop (Velcro) straps and minimum 1” slide buckles.

G. Jacket coverings shall have an inner covering edge with a continuous strip of hook & loop closure (Velcro) that is parallel to the seam and overlaps the outer covering by a minimum of 2 inches.

H. Acceptable Manufacturers: Firwin Corp, Lewco Specialty Products, ThermaXX Jackets LLC or approved equivalent.

PART 3 - EXECUTION

3.1 PREPARATION

A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

3.2 INSTALLATION

A. General Installation Requirements:

   1. Install materials per manufacturer’s instructions, building codes and industry standards.
   2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
3. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a 180° cylindrical segment the same length as metal shields. Inserts shall be a cellular glass (for all temperature ranges) or molded hydrous calcium silicate (for pipe with operating temperatures above 70°F, with a minimum compressive strength of 50 psi. Polyisocyanurate insulation with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" and above, and operate below 300°F. Factory fabricated inserts may be used. Rectangular blocks, plugs, or wood material are not acceptable. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

4. Neatly finish insulation at supports, protrusions, and interruptions.

5. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

6. Shields shall be at least the following lengths and gauges:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Shield Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 3&quot;</td>
<td>12&quot; long x 18 gauge</td>
</tr>
<tr>
<td>4&quot;</td>
<td>12&quot; long x 16 gauge</td>
</tr>
</tbody>
</table>

7. All piping and insulation that does not meet 25/50 that is in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has passed ASTM E84 and/or NFPA 255 testing with a rating of 25/50 or below.

B. Insulated Piping Operating Below 60°F:

1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.

2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.

3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.
D. Insulated Piping Operating Above 140°F:

1. Insulate fittings, valves, flanges, float & thermostatic steam traps, and strainers. On gate valves, the insulation shall be extended to cover the entire valve bonnet, leaving only the portion of the stem that is above the bonnet and valve operator exposed.

2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.

3. The use of removable insulation jackets is acceptable for insulating large and non-cylindrical shaped piping components (e.g., check valves, pressure regulating valves, calibrated balance valves, gate valve bonnets, F&T traps, strainers, line sets, and the like).

E. Refrigerant Piping:

1. On refrigerant piping (25°F and above) and **not** required to meet the 25/50 flame/smoke, provide at each strut or clevis support an insulation coupling to support pipe and to accept insulation thickness of adjoining insulation, to prevent insulation from sagging and crushing. The coupling shall be suitable for planned temperatures, use with specified pipe material, and shall be a 360°, one-piece cylindrical segment. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Contractor shall apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.

F. Exposed Piping:

1. Locate and cover seams in least visible locations.

2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

3. All new interior piping, exposed to view in occupied areas, shall be painted to match

G. All new interior piping, exposed to view in occupied areas, shall be painted to match the surrounding background.

H. **DO NOT INSULATE**

1. Hot piping within radiation enclosures or unit cabinets.

2. Cold piping within unit cabinets provided piping is located over drain pan.

3. Hot piping beyond control valve, located within heated space.

4. Condensate piping between the steam trap and the unions.

I. Mechanical Rooms:

1. In Mechanical Rooms, insulate all heat piping and accessories. All accessories shall be insulated with removable covers.
J. Provide removable covers and insulation on strainers and manual or automatic flow control valves.

K. Balance valves on chilled water need to have ports extended beyond the insulation. Sleeves are not desirable. Provide shaft extensions on all chilled water valve handles.

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

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

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

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

P. Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.3 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.

2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.

3. Apply insulation with laps on top of pipe.

4. Fittings, Valve Bodies and Flanges: For 4” and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4”, use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2” on itself. For pipes operating below 60ºF, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.

2. Self-seal insulation may be used on pipes operating below 170ºF.
3. Type C Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.

2. Insulate fittings with prefabricated fittings.

3.4 JACKET COVER INSTALLATION

A. Metal Covering:

1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.

2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.

3. Interior joints do not need to be sealed.

4. Use metal covering on the following pipes:
   a. All exterior piping.
   b. Engine exhaust piping (interior).
   c. All new interior piping in mechanical rooms within 6'-0" of the finished floor.

B. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.

2. Solvent weld all joints with manufacturer recommended cement.

3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.

4. Use plastic insulation covering on all exposed pipes including, but not limited to:
   a. All exposed piping in areas noted on drawings.
   b. All exposed piping in locker rooms.
   c. All exposed piping below 6'-0" above floor.
   d. All kitchen areas.
   e. All steam and steam condensate piping.
   f. All hot water piping.

5. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.

3.5 SCHEDULE

Refer to attached insulation schedule.

END OF SECTION
<table>
<thead>
<tr>
<th>Piping System</th>
<th>Insulation Thickness per Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;1&quot;</td>
</tr>
<tr>
<td>Saturated Steam, Condensate Return (30 to 134 psig, 350°F)</td>
<td>A 4-1/2&quot;</td>
</tr>
<tr>
<td>Below Grade</td>
<td>D 4&quot;</td>
</tr>
<tr>
<td>Saturated Steam, Condensate Return (135 to 250 psig, 450°F)</td>
<td>A 4-1/2&quot;</td>
</tr>
<tr>
<td>Below Grade, above 10&quot; pipe size</td>
<td>D 4&quot;</td>
</tr>
<tr>
<td>Chilled Water Supply &amp; Return (40°F-60°F Supply Water Temp)</td>
<td>B 1&quot;</td>
</tr>
<tr>
<td>located in air conditioned spaces</td>
<td>B 1&quot;</td>
</tr>
<tr>
<td>located in non-air conditioned spaces (mechanical rooms; exterior; attic, etc.)</td>
<td>B 1&quot;</td>
</tr>
<tr>
<td>located in modular chiller enclosure</td>
<td>B 1&quot;</td>
</tr>
<tr>
<td>located inside air handling unit airstream</td>
<td>B 1&quot;</td>
</tr>
<tr>
<td>Cooling Coil Condensate Drains below 55°F</td>
<td>B 1&quot;</td>
</tr>
</tbody>
</table>

**KEY NOTES FOR CONTRACTORS:**
- * Type J not allowed in return air plenum (not 25/50 rated)
- + Type B < 1" thickness shall be installed using multiple layers of 3/4" or 1"
- ** Two (2) 2" layers with staggered seams
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Extended System of Automatic Controls.
B. Control Devices, Components, Wiring and Material.
C. Instructions for Owners.
D. Remodeling.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.
B. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
C. Technician: Minimum five years’ experience installing commercial temperature control systems.
D. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

1.3 SUBMITTALS

A. Equipment Coordination:

1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.

2. Control valve selections shall be based on flow rates shown in approved shop drawings.

3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

B. Shop Drawings:

1. Submit shop drawings per Section 23 05 00. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.

2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.

3. Submittal shall also include a trunk cable schematic diagram depicting control panel locations and a description of the communication type, media and protocol.

4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and
control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.

5. Diagrams shall include:
   a. Wiring diagrams and layouts for each control panel showing all termination numbers.
   b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers’ model numbers and functions. Show all interface wiring to the control system.
   c. Identification of all control components connected to emergency power.
   d. Schematic diagrams for all field sensors and controllers.
   e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
   f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
   g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
   h. All installation details and any other details required to demonstrate that the system will function properly.
   i. All interface requirements with other systems.

6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.

8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history,
archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.

9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:
   a. Damper Identification Tag.
   b. Location.
   c. Damper Type.
   d. Damper Size.
   e. Duct Size.
   f. Arrangement.
   g. Blade Type.
   h. Velocity.
   i. Pressure Drop.
   j. Fail Position.
   k. Actuator Identification Tag.
   l. Actuator Type.
   m. Mounting.

10. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
    a. Valve Identification Tag.
    b. Location.
    c. Valve Type.
    d. Valve Size.
    e. Pipe Size.
    f. Configuration.
    g. Flow Characteristics.
    h. Capacity.
    i. Valve Cv.
    j. Design Pressure Drop.
    k. Pressure Drop at Design Flow.
    l. Fail Position.
    m. Close-off Pressure.
    n. Valve and Actuator Model Number and Type.

11. Airflow Measuring Station Schedule:
    a. The manufacturer’s authorized representative shall prepare the airflow measuring station submittal, or review and approve in writing the submittal prepared by the TCC prior to submission to the Architect/Engineer and prior to installation. The representative shall review air handling equipment submittals and duct fabrication drawings to ensure that all AFMS locations meet the appropriate parameters to achieve proper installation and the specified accuracy. Comply with all manufacturer’s installation requirements including straight up and downstream duct lengths. Install airflow straighteners if required by the manufacturer based on installation constraints. The Architect/Engineer shall be notified for approval of any deviations.
b. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.

c. Submit installation, operation, and maintenance documentation.

12. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer’s description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer’s literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

13. Provide PICS files indicating the BACnet® functionality and configuration of each device.

14. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer’s company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements if problems are found during BTL testing is required.

15. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.

16. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.

17. Clearly identify work by others in the submittal.

18. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Division 1, submit an electronic copy of the O&M manuals in PDF format.

2. Provide three complete sets of manuals.

3. Each O&M manual shall include:
   a. Table of contents with indexed tabs dividing information as outlined below.
   b. Definitions: List of all abbreviations and technical terms with definitions.
   c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.

e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.

f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.

g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.

h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.

i. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.

j. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.

D. Training Manual:

1. Provide a course outline and training manuals for each training class.

E. Record Documents:

1. Submit record documentation per Division 1.

2. Provide a complete set of “as-built” drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the “as-built” drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.

3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.

4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.

5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.
1.4 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Control Valves.
B. Flow Switches.
C. Temperature Sensor Sockets.
D. Gauge Taps.
E. Automatic Dampers.
F. Flow Meters.

1.6 AGENCY AND CODE APPROVALS

A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.

1. UL-916; Energy Management Systems.
2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 “Signal Equipment.”

1.7 ACRONYMS

A. Acronyms used in this specification are as follows:

1. B-AAC BACnet Advanced Application Controller
2. B-ASC BACnet Application Specific Controller
3. BTL BACnet Testing Laboratories
4. DDC Direct Digital Controls
5. FMCS Facility Management and Control System
6. GUI Graphic User Interface
7. IBC Interoperable BACnet Controller
8. IDC Interoperable Digital Controller
9. LAN Local Area Network
10. NAC Network Area Controller
11. ODBC Open DataBase Connectivity
12. OOT Object Oriented Technology
13. OPC Open Connectivity via Open Standards
14. PICS Product Interoperability Compliance Statement
15. PMI Power Measurement Interface
16. POT Portable Operator’s Terminal
17. TCC Temperature Control Contractor
18. TCS Temperature Control System
19. WAN Wide Area Network
20. WBI Web Browser Interface
1.8 SUMMARY

A. Extend Existing System:
   1. Extend the existing FMCS for this project.
   2. All controllers and accessories shall interface with the existing FMCS.

B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.

C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.

D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

1.9 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor’s responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

1.10 WARRANTY

A. Refer to Division 1 for warranty requirements.

B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.

C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.

D. Update all software and back-ups during warranty period and all user documentation on the Owner’s archived software disks.

1.11 WARRANTY ACCESS

A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

<table>
<thead>
<tr>
<th>Acceptable Manufacturers</th>
<th>BACnet Protocol</th>
<th>LonTalk Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siemens Building Technologies: APOGEE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2 NETWORK AREA CONTROLLER (NAC)

A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.

B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:

1. Calendar functions.
2. Scheduling.
3. Trending.
5. Time synchronization.
6. Integration of all controller data.
7. Network Management functions.

C. The Network Area Controller shall provide the following hardware features as a minimum:

1. One Ethernet Port – 10/100 Mbps.
2. One RS-232 port.
3. One LonWorks Interface Port – 78KB FTT-10A (for LonWorks systems only).
4. One RS-485 port.
5. Battery backup.
6. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
7. The NAC must be capable of operation over a temperature range of 32°F to 122°F.
8. The NAC must be capable of withstanding storage temperatures of between 0°F and 158°F.
9. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.

D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the NAC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.

F. Event Alarm Notification and Actions:

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
   a. Alarm
   b. Normal
4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g. security, HVAC, Fire, etc.

5. Provide timed (scheduled) routing of alarms by class, object, group, or node.

6. Provide alarm generation from binary object “runtime” and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Treat control equipment and network failures as alarms and annunciated.

H. Annunciate alarms in any of the following manners as defined by the user:
   1. Screen message text.
   2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
      a. Day of week.
      b. Time of day.
      c. Recipient.
   3. Pagers via paging services that initiate a page on receipt of e-mail message.
   4. Graphic with flashing alarm object(s).
   5. Printed message, routed directly to a dedicated alarm printer.

I. The FMCS shall record the following for each alarm:
   1. Time and date.
   2. Location (building, floor, zone, office number, etc.).
   3. Equipment tag.
   4. Acknowledge time, date, and user who issued acknowledgement.
   5. Number of occurrences since last acknowledgement.

J. Give defined users proper access to acknowledge any alarm.

K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

L. Provide a “query” feature to allow review of specific alarms by user-defined parameters.

M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

2.3 TERMINAL AIR BOX (TAB) CONTROLLERS

A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 23 36 00 for additional information.
B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.

C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.

D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator’s terminal connected to the specific controller.

E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.

F. BACnet TAB controllers shall either be B-AAC devices or B-ASC devices as required to meet the performance and BTL listing.

2.4 MODBUS SYSTEM INTEGRATION

A. The NAC shall support integration of device data from Modbus RTU, ASCII, and TCP control system devices. Connect to the Modbus system via an RS-232, RS485, or Ethernet IP as required by the device.

B. Provide the required objects in the library included with the GUI programming software to support the integration of the Modbus system data into the FMCS. Objects provided shall include, at a minimum:

1. Read/Write Modbus AI Registers.
2. Read/Write Modbus AO Registers.
3. Read/Write Modbus BI Registers.
4. Read/Write Modbus BO Registers.

C. The NAC shall perform all scheduling, alarming, logging and global supervisory control functions of the Modbus system devices.

D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment using Modbus shall provide documentation of the system’s Modbus interface and shall provide factory support at no charge during system commissioning.

2.5 CONTROL DAMPERS

A. Thermally Insulated Control Damper:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Extruded aluminum, minimum 4” deep, 0.080” minimum thickness.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6” wide, internally insulated with expanded polyurethane foam and thermally broken, with overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid aluminum or zinc plated steel shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.

6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.

7. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.

8. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.

9. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.

10. Maximum Leakage: Class 1A at 1” w.c. pressure differential for a 24”x24” damper.

11. Maximum Pressure Drop: 0.21” for 8,000 cfm through a 24”x24” damper (2000 fpm).

2.6 DAMPER ACTUATORS

A. Damper Actuators - Electronic - Spring Return:

1. Damper actuators shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).

2. Following power interruption, spring return mechanism shall close the damper. Mechanical spring shall be rated for a minimum of 60,000 full cycles. Provide breathable membrane in actuator housing to compensate for pressure differential and allow for 95% non-condensing relative humidity in the airstream.

3. Mount actuators with motor outside of airstream whenever possible. Unit casings shall have housing with proper weather, corrosive, or explosion-proof construction as required by application.

4. Actuators shall be rated for 60,000 full cycles at rated torque with 2-year unconditional warranty. Size actuators per damper manufacturer's recommendations.

5. Provide end switches as required for the sequence of operation.

6. Provide analog feedback signal for positive position indication. Refer to FMCS points list.
2.7 HYDRONIC CONTROL VALVES

A. General:

1. Two-position valves shall be a minimum of line size with a maximum allowable pressure drop of 2 psi.

2. Size two-way and three-way modulating valves to provide a pressure drop at full flow of 1 to 4 psi, except boiler three-way and cooling tower bypass valves shall not have a pressure drop over 2 psi.

3. Two-way valves shall be 100% tight-closing. Three-way valves shall be 100% tight-closing in both extreme positions.

4. Modulating two-way valves shall have equal percentage flow characteristics.

5. Modulating three-way valves shall have linear flow characteristics.

6. Piping geometry correction factors for $C_v$ ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

7. Control valves shall be pressure independent.

B. Two-position:

1. Ball 2” and under:
   a. Design Pressure: 400 psi
      Design Temperature: 212°F
      Design Flow Differential Pressure Rating: 150 psi
   b. Bronze or brass body, stainless steel stem, chrome plated brass or stainless steel full port ball, PTFE or RTFE seats and seals, screwed ends (solder ends are acceptable only if rated for soldering in line with 470°F melting point of 95-5 solder).

2. Ball 3” to 6”:
   a. Design Pressure: 200 psi
      Design Temperature: 212°F
      Design Flow Differential Pressure Rating: 35 psi
   b. Cast iron body, stainless steel stem, stainless steel full port ball, PTFE or RTFE seats and seals, flanged ends.

3. Butterfly 2-1/2” to 12”:
   a. Design Pressure: 125 psi
      Design Temperature: -20 to 212°F
      Design Flow Differential Pressure Rating: 50 psi
   b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.
C. Modulating:

1. Globe 1/2" to 2":
   a. Design Pressure: 250 psi
      Design Temperature: 212ºF
      Design Flow Differential Pressure Rating: 35 psi
   b. Bronze or brass body, trim and plug; stainless steel stem; stainless steel or bronze seat; EPDM or PTFE packing; threaded ends.

2. Globe 2-1/2" to 6":
   a. Design Pressure: 125 psi
      Design Temperature: 250ºF
      Design Flow Differential Pressure Rating: 25 psi
   b. Cast iron body, bronze or brass trim and plug; stainless steel stem; bronze seat; EPDM or PTFE packing; flanged ends.

3. Ball 2" and under:
   a. Design Pressure: 400 psi
      Design Temperature: 212ºF
      Design Flow Differential Pressure Rating: 35 psi
   b. Bronze or brass body, nickel plated brass or stainless steel stem, chrome plated brass or stainless steel ball, PTFE or RTFE seats and seals, screwed ends (solder ends are acceptable only if rated for soldering in line with 470ºF melting point of 95-5 solder).

4. Ball 3" to 6":
   a. Design Pressure: 200 psi
      Design Temperature: 212ºF
      Design Flow Differential Pressure Rating: 35 psi
   b. Cast iron body, stainless steel stem, stainless steel full port ball, PTFE or RTFE seats and seals, flanged ends.

5. Butterfly 2-1/2" to 12":
   a. Design Pressure: 125 psi
      Design Temperature: -20 to 212ºF
      Design Flow Differential Pressure Rating: 50 psi
   b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.
2.8 STEAM CONTROL VALVES

A. General:

1. Two-position valves shall have a maximum pressure drop equal to 10% of the inlet pressure.

2. Modulating control valves shall have modified linear characteristics.

3. Two modulating control valves in parallel shall have 1/3 – 2/3 capacities sequenced so that the smaller valve opens first.

4. The pressure drop through a modulating control valve with an inlet pressure less than or equal to 15 psig shall be equal to 80% of the inlet pressure. In no case shall the inlet pressure of the equipment after the valve be less than 2 psig, except for integral face and bypass coils where the inlet pressure after the valve shall not be less than 5 psig.

5. The pressure drop through modulating control valves with inlet pressures greater than 15 psig shall be required to provide outlet pressure of 1 psi above the scheduled or specified inlet pressure of the equipment served.

6. Piping geometry correction factors for $C_v$ ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

B. Two-Position or Modulating (Low Pressure: 15 psi or below):

1. Globe 1/2” to 2”:
   a. Design Pressure: 100 psi
      Design Temperature: 337ºF
   b. Bronze body; stainless steel trim, plug, stem and seat; EPDM or PTFE packing; threaded ends.

2. Globe 2-1/2” to 6”:
   a. Design Pressure: 100 psi
      Design Temperature: 337ºF
   b. Cast iron body; stainless steel trim, plug, stem and seat; EPDM or PTFE packing; flanged ends.

2.9 VALVE ACTUATORS

A. General:

1. Actuators shall be sized to operate the valve through its full range of motion and shall close against pump shutoff pressure without producing audible noise at any valve position.

2. Provide visual position indication.

3. Mount actuator directly on valve or provide linear motion assembly as required for valve type.
B. Valve Actuators - Electronic:

1. Actuator shall be UL listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation, and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).

2. Actuators shall be rated for 60,000 full stroke cycles at rated torque. Stall motor not acceptable.

3. Tri-state/floating actuators shall have auto-zeroing function for realigning valve position.

4. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.

5. Spring return actuators shall have an internal spring return mechanism. Non-mechanical forms of fail-safe operation are not acceptable.

6. Provide analog feedback signal for positive position indication as required by control diagrams.

2.10 CONTROL INSTRUMENTATION

A. Temperature Measuring Devices:

1. Electric Thermostats:

   a. Single Temperature - Line Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, concealed temperature adjustment, locking cover, rated for load, single or double pole as required.

   b. Single Temperature - Low Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, anticipator circuits, concealed temperature adjustment, locking cover, 24 V control transformer (if not included with unit under control), single or double pole as required.

2. Low Limit Switch:

   a. Provide one foot of sensing element for each one square foot of coil area, maximum element length 25 feet, of the vapor tension type, so that any point along the entire length of measuring element can trigger the switch.

   b. Provide 3" minimum radius capillary support clips at each turn.

   c. Furnish each thermostat with one single pole, single throw normally-opened switch and one single pole, single throw normally-closed auxiliary switch.

   d. Setpoint range shall be 15°F to 55°F with a permanent stop at 35°F.

   e. Differential shall be fixed at approximately 5°F and supplied with manual reset.
B. Temperature Sensors:

1. Room Temperature Sensor:
   a. Sensor Only: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, ± 0.50°F accuracy, no setpoint adjustment or override button.
   b. Sensor with Setpoint Adjustment: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, ± 0.50°F accuracy, with exposed single setpoint adjustment (no numeric temperature scale – provide with a single warmer/cooler or red/blue visual scale), no override button.
   c. Sensor with Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, ± 0.50°F accuracy, occupied/unoccupied override button with LED, no setpoint adjustment.
   d. Sensor with Setpoint Adjustment and Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, ± 0.50°F accuracy, with exposed single setpoint adjustment (no numeric temperature scale – provide with a warmer/cooler or red/blue visual scale), occupied/unoccupied override button with LED.

2. Duct Temperature Sensor:
   a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.

3. Water Temperature Sensor:
   a. Install in immersion wells. Separate thermometers as specified elsewhere, also of the immersion well type, shall be installed within 2 feet of each temperature sensor.

C. Humidity Measuring Devices:

1. Humidity Sensors:
   a. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be ± 5% of reading.

D. Enthalpy Sensors. Duct-mounted enthalpy sensor shall include solid state temperature and humidity sensors with electronics that shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.
E. Pressure Measuring Devices

1. Differential Pressure Switches:
   a. Standard Pressure Switches:
      1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
      2) Accuracy shall be ± 3% of full scale maximum throughout entire range at 70°F.
      3) Provide mounting brackets, probes, and shutoff valves required for proper installation.
      4) The range and service shall be as required for application or as noted on the drawings.
      5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.
      6) Provide latching relays that require manual reset once activated.
      7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.
   b. High Pressure Switches (Manual Reset):
      1) Differential pressure switch with single pole, double-throw snap switch and enclosure.
      2) Rated for pressure specified in sequence of control.
      3) Electrical rating shall be 15 amps at 120-480 volts.
      4) Setpoint adjustment shall be screw type located inside enclosure.
      5) Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.
      6) Repeatability: ± 3%.

2. Pressure Transmitters/Transducer:
   a. Select device suitable for intended application; water or air, static or differential.
   b. Select for appropriate range, including negative if applicable.
   c. 100% solid state device, temperature compensated, suitable for pressures of 200% rated range with averaging to stabilize output, accuracy of ± 1% full scale, and a 4-20 mA output.
   d. Provide a NEMA 4 enclosure unless panel mounted.
   e. Air service shall have a minimum of three field selectable ranges.
f. When used for room pressure control, the transducer shall be bidirectional with a range of ± 0.1” W.C.

g. Provide pressure line outlet cover on both sides of the wall when used for room pressure control.

h. Furnish with integral LED’s to indicate Zero Pressure, Pressure In Range, and Pressure Out Of Range as a diagnostic aid.

F. Flow Measuring Devices:

1. Flow Switches:
   a. Suitable for the intended application (water or air system).
   b. Vane Operated Flow Switch: Vane motion shall activate a single pole, double throw snap switch.

2. Airflow Measuring Stations:
   a. Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion:
      1) Provide airflow/temperature measurement devices where indicated on the plans.
      2) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
         a) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
         b) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
         c) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
         d) Devices using less than two thermistors in each sensor assembly are not acceptable.
         e) Devices using platinum wire RTDs are not acceptable.
         f) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
         g) Pitot tubes and arrays are not acceptable.
         h) Vortex shedding devices are not acceptable.
3) All Sensor Probes:
   a) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.
   b) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
   c) Airflow measuring station assembly accuracy shall be +/-2% of Reading over the entire operating airflow range. Temperature accuracy shall be +/-0.15°F between -20°F and 160°F.
   d) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
   e) Each sensor probe shall have an integral, UL listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.
   f) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.

4) Duct and Plenum Probes:
   a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
   b) Probe assembly mounting brackets shall be constructed of 304 stainless steel.
   c) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5) Sensor Density:

<table>
<thead>
<tr>
<th>Area (sq.ft.)</th>
<th>Total # of Sensors Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2</td>
<td>4</td>
</tr>
<tr>
<td>2 to &lt; 4</td>
<td>6</td>
</tr>
<tr>
<td>4 to &lt; 8</td>
<td>8</td>
</tr>
<tr>
<td>8 to &lt; 16</td>
<td>12</td>
</tr>
<tr>
<td>≥ 16</td>
<td>16</td>
</tr>
</tbody>
</table>

6) Transmitters:
   a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
   b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
c) The operating temperature range for the transmitter shall be -20° F to 120° F.

d) The transmitter shall be capable of communicating with other devices using one of the following interface options:

(1) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)

(2) RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

(3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.

(4) LonWorks Free Topology

b. Fan Inlet Airflow Measuring Stations (AFMS) - Thermal Dispersion:

1) Sensor assemblies shall be mounted on 304 stainless steel housings.

2) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.

3) Mounting feet shall be constructed of 304 stainless steel and securely riveted in place to prevent loosening over time due to vibration.

4) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.

5) Transmitters

a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.

b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.

c) The operating temperature range for the transmitter shall be -20° F to 120° F.
d) The transmitter shall be capable of communicating with other devices using one of the following interface options:

1. Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)

2. RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

3. 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.

4. LonWorks Free Topology

6) The AFMS shall be UL listed as an entire assembly.

G. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:
   a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:
   a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

H. Miscellaneous Devices:

1. Control Relays:
   a. Form “C” contacts rated for the application with “push-to-test” contact transfer feature and an integral LED to indicate coil energization.
b. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.

2.11 CONDUIT AND BOXES

A. Conduit and Boxes: Refer to Electrical Section 26 05 33 for materials, sizing, and other requirements.

B. Conduit and Box Identification (Color and Labeling):
   1. Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for raceway and box color requirements.
   2. Refer to Electrical Section 26 05 53 for raceway and box labeling requirements.

2.12 WIRE AND CABLE

A. Wire and Cable: Refer to Electrical Section 26 05 13 for wire and cable materials.
   1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for wire and cable color requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.

B. Install system and materials in accordance with manufacturer’s instructions.

C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.

D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.

E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed 48".

F. Provide valves over 3/4” size with position indicators and pilot positioners where sequenced with other controls.

G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.

H. After completion of installation, test and adjust control equipment.

I. Check calibration of instruments. Recalibrate or replace.
J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.

K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall be powered from the equipment branch. In no instance shall panel be connected to the life safety or critical branch of the emergency power system. Panels may be connected to a common 20 amp, 120 volt circuit provided the total load on the circuit does not exceed 16 amps. Circuit conductors shall be sized per the table below. All power connections to the control panels shall be performed by a licensed electrician at the cost of this Contractor. Submit circuit information (total amperage on circuit, conductors length, and panel) for control panels to the Architect/Engineer for approval.

<table>
<thead>
<tr>
<th>Circuit Load (Amps)</th>
<th>Circuit Max Length</th>
<th>Feeder Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 5</td>
<td>≤ 160 ft</td>
<td>2#12 &amp; 1#12 ground in 3/4&quot; conduit.</td>
</tr>
<tr>
<td>≤ 10</td>
<td>≤ 100 ft</td>
<td>2#12 &amp; 1#12 ground in 3/4&quot; conduit.</td>
</tr>
<tr>
<td>≤ 16</td>
<td>≤ 75 ft</td>
<td>2#12 &amp; 1#12 ground in 3/4&quot; conduit.</td>
</tr>
<tr>
<td>≤ 200</td>
<td>≤ 325 ft</td>
<td>2#10 &amp; 1#10 ground in 3/4&quot; conduit.</td>
</tr>
<tr>
<td>≤ 100</td>
<td>≤ 160 ft</td>
<td>2#10 &amp; 1#10 ground in 3/4&quot; conduit.</td>
</tr>
<tr>
<td>≤ 75</td>
<td>≤ 100 ft</td>
<td>2#10 &amp; 1#10 ground in 3/4&quot; conduit.</td>
</tr>
</tbody>
</table>

L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.

M. Remodeling:

1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. If wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.

N. Labels For Control Devices:

1. Provide labels indicating service of all control devices in panels and other locations.

2. Labels may be made with permanent marking pen in the control panels if clearly legible.

3. Use engraved labels for items outside panel such as outside air thermostats.

4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.
O. VFDs:

1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.

2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.

3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.

4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.

5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

P. Airflow Stations:

1. The transmitter shall be installed at a location that is protected from weather, water, and vibration.

2. Mount transmitter where they can easily be read (36” to 66” above floor). Do not fasten transmitters directly to ductwork or compromise duct insulation.

3. The manufacturer’s authorized representative shall visit the project site during construction prior to station installations to confirm all submitted sizes, mounting requirements and locations. Size adjustments shall be made at no additional cost. The representative shall meet on site with the TCC to support and train them on proper installation procedures and calibration.

4. Install labels at each sensor and transmitter identifying its service.

3.2 GRAPHIC DISPLAY

A. Create a customized graphic for each piece of equipment indicated on the itemized points list.

B. Components shall be arranged on graphic as installed in the field.

C. Include each graphic point listed in the itemized points list using real time data.

D. Provide a graphic representation of the following:

1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building’s systems.

2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.

3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area’s AHU.
4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone’s TAB graphic.

5. Show the location of each thermostat on the floor plan.

6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.

7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.

E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:

1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.

F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:

1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

3.3 CONDUIT AND BOXES INSTALLATION

A. Conduit and Box Installation: Refer to Electrical Section 26 05 33 for execution and installation.

B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 26 05 53 for raceway and box identification installation.

C. Outlet Box Schedule: Thermostat/temperature sensor:

1. Dry Interior Locations: Provide 4” square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.
2. Other Conditions: Refer to Electrical Section 26 05 33 for requirements.
3.4 WIRE AND CABLE INSTALLATION

A. Wire and Cable Installation: Refer to Electrical Section 26 05 13 for execution and installation.

B. Field Quality Control:
   1. Inspect wire and cable for physical damage and proper connection.
   2. Torque test conductor connections and terminations to manufacturer’s recommended values.
   3. Perform continuity test on all conductors.
   4. Protection of cable from foreign materials:
      a. It is the Contractor’s responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer’s performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
      b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor’s responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

C. Installation Schedule:
   1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

3.5 FMCS INSTALLATION

A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.6 COMMISSIONING

A. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.

B. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

C. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.7 PREPARATION FOR BALANCING

A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).

B. Check the calibration and setpoints of all controllers.

C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.

D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.

E. Verify the operation of all interlock systems.

3.8 TEST AND BALANCE COORDINATION

A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.

C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.

D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

3.9 DEMONSTRATION AND ACCEPTANCE

A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.
3.10 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer’s recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12” apart and within 6” of the top and bottom of the area.

F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.

H. Install all wall-mounted CO2 sensors between 3 feet and 6 feet above the floor.

END OF SECTION
SECTION 23 09 13
INSTRUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Positive Displacement Meters.
B. Pressure Gauge.
C. Pressure Gauge Accessories.
D. Thermometers.
E. Test Plugs.
F. Static and Differential Airflow Pressure Gauges.

1.2 SUBMITTALS

A. Submit shop drawings per Section 23 05 00. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for air, steam, water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze brushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.

B. Acceptable Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Trerice, U.S. Gauge Figure 1901, Weiss, Weksler, Wika.

2.2 PRESSURE GAUGE ACCESSORIES

A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.

B. Shutoff Valve: 1/4" ball valve as specified for each piping system.

C. Pressure snubber, brass with 1/4" connections, porous metal type.

2.3 THERMOMETERS

A. Dial Type:

1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.

2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.

3. Stem lengths as required for application with minimum insertion of 2-1/2".
4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.


B. Alcohol/Spirit Filled Type:

1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, and locking device to allow rotation of thermometer to any angle.

2. Select thermometer for appropriate temperature range.

3. Stem: Copper plated steel, aluminum, or brass for separable socket. Stem lengths as required for application with minimum insertion of 3”.

4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.


C. Digital Type:

1. 1/2” LCD digital display, solar powered, with high impact ABS case. Accuracy of 1% of reading or 1°F, whichever is greater. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.

2. Fahrenheit/Celsius switchable with -50/300°F or -45/150°C range.

3. Through-case potentiometer recalibration adjustment.

4. Stem lengths as required for application, with minimum insertion of 2-1/2”.

5. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.

6. Digital display shall operate at 10 Lux (one foot-candle) or more. Use this thermometer only where ambient temperatures are below 140°F and there is sufficient light under normal occupied space conditions for the digital display to function. Use a different type thermometer where there is inadequate light available (i.e., dark mechanical rooms, locations where the thermometer is shielded from light, etc.).

D. Dial Type with Remote Reading Dial:

1. 4-1/2" diameter remote mounted, vapor actuated dial, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.

2. Select thermometers for appropriate temperature range.

3. 0.13" diameter copper averaging bulb approximately 60" long. Install dial as shown on drawings and in location visible from floor. Insulate copper averaging bulb if required by manufacturer.

4. Stem lengths as required for application with minimum insertion of 2-1/2".

5. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.


E. Select scales to cover expected range of temperatures.

2.4 TEST PLUGS

A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.

B. Provide extended units for all plugs installed in insulated piping.

C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" diameter pressure gauge with 0-100 psi range, one gauge adapter with 1/8" probes, two 1-1/2" dial thermometers with 0° to 220°F and -25°F to 125°F ranges and 5" stems.


2.5 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES

A. Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.

B. Accuracy shall be ± 3% of full scale maximum throughout entire range at 70°F.

C. Provide mounting brackets, probes, and shutoff valves required for proper installation.

D. The range and service shall be as required for application or as noted on the drawings.
PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install per manufacturer’s instructions.
2. Coil and conceal excess capillary on remote element instruments.
3. Install gauges and thermometers in locations where they are easily read from normal operating level.
4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Pressure Gauges:

1. Connect pressure gauges to suction and discharge side of all pumps.
2. Provide snubber for each pressure gauge.
3. Provide coil syphon for each pressure gauge connected to steam piping.

C. Thermometers:

1. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.
3. Locate duct thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.
B. Valves.
C. Heating Water Piping System.
D. Chilled Water Piping System.
E. Dielectric Connections.

1.2 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.
C. All work shall conform with ANSI B31.9 and International Mechanical Code.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
B. Deliver and store valves in shipping containers with labeling in place.

1.4 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 23 05 00 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

1.5 SUBMITTALS

A. Provide and submit for approval to the owner's representative a Hydrostatic Test Report on hydronic Water Systems.

PART 2 - PRODUCTS

2.1 HEATING WATER

A. Design Pressure: 125 psig.
   Maximum Design Temperature: 225°F. (230°F for mechanical couplings)

B. Piping - 2" and Under:
   1. Tubing: Type L drawn temper seamless copper tube, ASTM B88.
   2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.

CHILLED WATER

C. Piping - 2” and Under (Contractor's Option):

1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.

D. Piping - All Sizes:

1. Pipe: Standard weight black steel, beveled ends, ASTM A53, Type E or S, Grade B.
2. Joints: Butt-welded or flanged, threaded for 2” and smaller.
4. Flanges: Class 150 forged steel, welding neck or slip-on, ASTM A181 or A105, Class 60, ASME B16.5 up to 24” and B16.47 above 24”. ASME B16.1 for flanges mating with flat face equipment flanges. Flange face seal weld (backweld) is required for slip-on flanges.

E. Piping - 2” and Over

1. Pipe: Standard weight black steel, grooved ends, ASTM A53, Type E or S, Grade B.
3. Fittings: ASTM A536 Grade 65-45-12 ductile or A47 malleable iron, grooved type.
4. Flanges: Grooved end, flanged adapter.

F. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Gate Valves:
   a. GA-1: 2” and under, 125 psi S @ 353°F, 300 psi WOG @ 150°F, screwed, bronze, rising stem, screwed bonnet. Crane #431, Hammond #IB641, Stockham #B122, Walworth #56, Milwaukee #1150, Watts #B-3210, NIBCO #T-131.
   b. GA-2: 2-1/2” thru 12”, 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted, OS&Y. Crane #465-1/2, Hammond, Stockham #G623, Walworth, Milwaukee #F2885, Watts #F-503, NIBCO F-617-O.
c. GA-5: 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, solder bronze. Crane #1334, Stockham #B108, Walworth #4SJ, Watts #B-3101, NIBCO #S-111.

3. Ball Valves:

a. BA-1: 3" and under, 150 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and stem, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

1) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.

2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

b. BA-1A: 2-1/2" and 3", 150 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

NOTES:

1) Provide extended shaft for all valves in insulated piping.

2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

4. Butterfly Valves:

a. BF-1:

1) 2-1/2" thru 6", 175 psi WOG, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10

2) 8" thru 12", 175# WOG, elastomers for 20°F to 225°F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1G, Nibco N200 Series or LD2000 Series, Milwaukee CL series, Hammond 5200 series.

3) Mechanically coupled grooved end valves are acceptable if they have the features listed above. Victaulic #300, Nibco GD4765.

b. BF-5:

1) 14" through 24", 150 psi WOG, elastomers rated for 20°F to 250°F at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or nickel plated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 150 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system). Weatherproof gear operator. Cv of at least 12,000 in 16" size. Victaulic #709, Center Line Series 200, Keystone #AR2, Watts DBF-03-121-1G, NIBCO LD2000 Series, Victaulic #W761, Milwaukee CL series, Hammond 5200 series.

G. Throttling Valves:

1. For pipe systems where mechanical press connections are allowed, throttling valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

2. Globe Valves:

a. GL-1: 2" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #95, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, NIBCO #T-235.

b. GL-2: 2-1/2" thru 10", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #906F, Milwaukee #F2981, Watts #F-501, NIBCO #F-718-B.

c. GL-5: 2" and under, 300 psi WOG, solder, bronze. Hammond #IB423, Stockham #B24T, Milwaukee #1590, Watts #B-4011-T, NIBCO #S-235.
3. Butterfly Valves:
   a. BF-4:
      1) 2-1/2" thru 6", 175 psi WOG, elastomers rated for 20°F to 250°F at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size. Victaulic #300, Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, NIBCO N200 Series or LD2000 Series, Milwaukee CL series, Hammond 5200 series.
      2) 8" thru 12", 175# WOG, elastomers for 20°F to 225°F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1G, NIBCO N200 Series or LD2000 Series, Victaulic #300, Milwaukee CL series, Hammond 5200 series.
   b. BF-5:
      1) 14" through 24", 150 psi WOG, elastomers rated for 20°F to 250°F at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or nickel plated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 150 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system). Weatherproof gear operator. Cv of at least 12,000 in 16" size. Victaulic #709, Center Line Series 200, Keystone #AR2, Watts DBF-03-121-1G, NIBCO LD2000 Series, Victaulic #W761, Milwaukee CL series, Hammond 5200 series.

H. Check Valves:
   1. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
   2. CK-1: 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319, Walworth #406, Milwaukee #509, Watts #B-5000, or NIBCO #T-413.
3. **CK-4**: 2” and under, 200 psi WOG @ 150°F, solder, bronze, horizontal swing. Crane #1342, Hammond #IB912, Stockham #B309, Walworth #406SJ, Milwaukee #1509, Watts #B-5001, or NIBCO #S-413.

4. **CK-13**: 2-1/2” thru 12”, 200# WOG, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6” size. Mueller Steam Specialty Co. #71-AHB-6-H, Stockham #WG-961, NIBCO W-920-W, Crane, Victaulic #716/716H.

I. **Strainers**:

1. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

2. **ST-1**: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi WOG @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777, NIBCO T-122.

3. **ST-2**: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi WOG @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co. #758, Sarco #CI-125, Watts #77F-D, Victaulic #732 or #W732, NIBCO F-721-A.

2.2 **EQUIPMENT DRAINS AND OVERFLOWS**

A. **Steel Pipe**: ASTM A53, Schedule 40 galvanized.


3. Service: Not allowed on boiler drains and overflow.

B. **Copper Tubing**: DWV drawn temper seamless copper drainage tube, ASTM B306.

1. Fittings: ASME B16.23 cast brass, or ASME B16.29 solder wrought copper.

2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.

C. **Piping 4” and Under (Contractor’s Option)**:

1. Tubing: Type M (or thicker) drawn temper seamless copper tube, ASTM B88.


D. **Piping Under 1-1/4” Size**:

1. In sizes where drainage type fittings are not available, tees with threaded caps to permit rodding are acceptable.
E. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

2. Ball Valves:

   a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

   NOTES:

   1) Provide extended shaft for all valves in insulated piping.

   2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

   b. BA-1A: 2-1/2" and 3", 150 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

   NOTES:

   1) Provide extended shaft for all valves in insulated piping.

   2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

2.3 AIR VENTS

A. Automatic air vents shall be Spirotherm Spirotop Air Release Valve. Size, ½”, designed not to leak. Route air vent discharge in ¼” copper tubing to floor drain.

2.4 AUTOMATIC AIR VENTS

A. Low capacity automatic air vent (for bladder tank anti-thermosyphon loops). Maximum operating pressure and temperature of at least 240°F and 125 psi, 1/2" or 3/4" inlet. B&G #87, Armstrong, Spirotherm, Taco, or Watts.
B. High/low capacity automatic air vent (for air separator connection). Maximum operating pressure and temperature of at least 240°F and 125 psi, 3/4" inlet, 3/8" minimum outlet. B&G #107, Armstrong, Spirotherm, Taco, or Watts.

2.5 STRAINERS

A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>1/4&quot; - 2&quot;</th>
<th>2-1/2&quot; - 8&quot;</th>
<th>10&quot; and Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air and Gases</td>
<td>1/32&quot;</td>
<td>3/64&quot;</td>
<td>1/16&quot;</td>
</tr>
<tr>
<td>Water and Glycol/Water</td>
<td>1/32&quot;</td>
<td>1/16&quot;</td>
<td>1/8&quot;</td>
</tr>
</tbody>
</table>

B. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.

C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.6 SAFETY RELIEF VALVES

A. SRV-1 (Hydronic Heating Systems): Spring-loaded disc type with cast iron or bronze body, bronze or stainless steel disc, side outlet and lifting lever for maximum service of 125 psig at 250°F. For relieving water during pressure fluctuations and in case of control failure. Capacities shall be ASME Section IV certified and labeled. Acceptable Manufacturers: Kunkle # 537, B&G, Conbraco, McDonnell & Miller, or Watts.

2.7 TRIPLE DUTY VALVE

A. Type TD-1: 2" and above, 175 psi working pressure, flanged, cast iron, non-slam check valve, calibrated throttling, shutoff capabilities, angle or straight pattern. Pressure drop with design flow at 100% open shall not exceed 10 feet. Size to match pipe (not pump outlet) size but reduce size by not more than one (1) if needed to provide at least 3 feet of differential pressure across the flow measuring taps at scheduled flow rate. Acceptable Manufacturers: Armstrong, Bell & Gossett, Taco, Wheatley, Victaulic.

B. Triple duty valves may replace the combination of shutoff valve, balancing valve, and check valve on constant volume systems. Triple duty valves are not permitted on variable volume systems.

2.8 SUCTION DIFFUSER

A. Furnish and install on base mounted pumps with inlet size same as pipe size shown on the drawing.

B. In no case shall pressure drop exceed 3.0 psi.

C. Suction diffuser shall consist of angle body with inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection, gauge tappings, and blowdown connection. Orifice cylinder, with bronze or stainless steel strainer with free area at least 5 times cross section area of pump suction opening. Furnish adjustable foot to support weight of suction piping. Connect drain valve to blowdown connection. Provide 16 mesh bronze startup strainer. The startup strainer shall be removed after the system has been started, cleaned, and is operating under normal conditions, but before the system is turned over to the Owner. Hang the startup strainer on the piping near the pump after it is removed.
D. Acceptable Manufacturers: Amtrol, Armstrong, Bell & Gossett, Patterson, Taco, Wheatley, Victaulic.

2.9 BALANCING VALVE

A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.

B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.

C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:
   1. Carrying case with handle.
   2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
   3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.

D. Valves in copper piping shall be brass or bronze.
   1. Quarter-Turn Ball Valve Style:
      a. Bell & Gossett "Circuit Setter Plus",
   2. Quarter-Turn Venturi Style:
      a. Presso “B+”
      b. Griswold “Quickset”
      c. Gerand “BALVALVE Venturi”
      d. HCI “Terminator B”
      e. Nexus Valve “UltraXB Orturi”
      f. MI Hydronic Engineering “Accusetter”
   3. Multi-Turn Style:
      a. Tour&Anderson (STAD)
      b. Armstrong "CBV"
      c. Victaulic 785
      d. Macon STVL/STV
      e. MEPCO MBV
      f. Wheatly GS
      g. NIBCO 1710
E. Valves in ferrous piping 2" or smaller shall have threaded ends and steel, brass or bronze construction. Option to balancing valves noted above are flow sensors specified in Section 23 09 00 with a specified throttling valve.

1. Quarter-Turn Ball Valve Style:
   a. Bell & Gossett "Circuit Setter Plus"

2. Quarter-Turn Venturi Style:
   a. Presso “B+”
   b. Gerand “BALVALVE Venturi”
   c. HCI “Terminator B”
   d. Nexus Valve “UltraXB Ortur”
   e. IMI Hydronic Engineering “Accusetter”

3. Multi-Turn Style:
   a. TA Hydronics “786-789”
   b. Armstrong “CBV”
   c. Victaulic 787
   d. Macon STVL/STV
   e. MEPCO MBV
   f. Wheatly GSNIBCO 1710 (T1710L)

F. Balancing valves in ferrous piping over 2" size shall have flanged or grooved ends and steel or cast-iron construction. Option to balancing valves noted above are flow sensor specified in Section 23 09 00 with a specified throttling valve.

1. Quarter-Turn Ball Valve Style:
   a. B&G “Circuit Setter”

2. Quarter-Turn Venturi Style:
   a. Presso “B+”,
   b. Taco “Accu-flo”,
   c. HCI “Terminator G”
   d. Nexus Valve “Nextrol NXFB”,
   e. IMI Hydronic Engineering “Accusetter”,

3. Multi-Turn Style:
   a. Armstrong "CVB-II",
   b. Tour&Anderson (STAF, STAG),
   c. Victaulic 788/789
   d. Macon STVA
   e. MEPCO MBV
   f. NIBCO 737

[***** OR *****]

G. Balancing valves in ferrous piping over 2" size shall consist of flow sensors as specified in Section 23 09 00 combined with specified throttling valves.
2.10 AUTOMATIC FLOW CONTROL VALVES (AUTOMATIC BALANCING VALVES)

A. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within ± 10% of the specified GPM over at least 95 percent of the control range.

B. Pump Head Requirements:
   1. The permanent pressure loss added to the pump head shall not exceed 7 feet.

C. Each valve shall have two P/T ports.

D. Five-year product warranty and first year cartridge exchange, up to 10 percent.

E. The internal wear surfaces of the valve cartridge shall be stainless steel or polyphenylsulfone orifice with an elastomeric diaphragm.

F. The internal flow cartridge shall be permanently marked with the GPM and spring range.

G. Valve body shall be brass on all valves 2” and under and ductile iron on all valves 2-1/2” and larger.

H. All valves shall be factory leak tested at 100 psi air under water.

I. A differential pressure test kit shall be supplied to verify flow and measure over-heading. The kit shall consist of a 4-1/2” diaphragm gauge equipped with 10 foot hoses and P/T adapters all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0-65 PSID for 5-60 PSI range.


K. Complete integral piping package, which integrate shutoff valves, automatic flow control valves, vents, strainers and drains, are acceptable.

2.11 COMBINATION PIPING PACKAGES

A. Combination piping packages are allowed in lieu of individual components specified for hydronic coils and devices containing hydronic coils. Combination piping packages shall include shutoff valves, wye strainers, 1/4 turn strainer blow down valves with hose thread and cap, manual balancing valves with memory stop, test plugs, manual air vents, and unions. Automatic flow control devices are not allowed. Configuration of combination pieces shall match layouts on the drawings. Each component of the combination piping packages shall meet these specifications for the individual components being combined.


2.12 CONNECTIONS BETWEEN DISSIMILAR METALS

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron
transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron and steel connected to each other.
2. Brass, copper, and bronze connected to each other.
3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

1. Do not use dielectric unions when joining dissimilar metals. Use a dielectric waterway equal to Victaulic or Clearflow.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.

F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.

G. Flexible Connectors: Stainless steel, woven braided design. Rubber type connectors are not permitted.
2.13 LOCK OUT TRIM

   A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in heating water piping over 120°F and as indicated on the drawings.

PART 3 - EXECUTION

3.1 PREPARATION

   A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
   B. Remove scale and dirt on inside and outside before assembly.
   C. Connect to all equipment with flanges or unions.
   D. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

3.2 TESTING PIPING

   A. Acceptance Testing: Perform hydrostatic tests on the hydronic piping in accordance with ANSI B 31.9 and as follows:
      1. Notify Owners Representative 24 hours before required testing. All tests shall be conducted in the presence of the Owners Representative.
      2. Flush system with clean water. Clean strainers.
      3. Minimum test pressure shall be 100 PSIG.
      4. Pressure gauge shall be min 4” diameter face, 0-160 PSIG, and shall be calibrated within 1 year of test date.
      5. Test pressure shall be held for 1 hour.
      6. Prepare reports for all tests and required corrective action.
      7. 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.
      8. System shall be operated for a minimum of 24 hours to demonstrate to the Owner's Representative that system is complete and operational.

3.3 CLEANING PIPING

   A. Assembly:
      1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.

3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.

4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

B. Chemical Cleaning:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 feet/second for 30 minutes. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of pipes, ends of headers and as otherwise needed to flush entire system. After flushing, all residual water shall be drained and/or blown out.

2. Add 2 pounds of trisodium phosphate per 100 gallons of system capacity. Use an alternate chemical if discharge of trisodium phosphate is not permitted. Maintain 150°F in the system if possible. If heat is not available, use 3 pounds per 100 gallons.

3. Drain the system after circulating the chemical cleaner for six hours at 150°F, or 12 hours at a lower temperature. Refill. Test a water sample. Drain and fill again if excessive cleaning chemicals remain and until water appears clear.

4. After each system has been cleaned and thoroughly flushed of pretreatment chemicals, it shall be immediately refilled with water and treated with chemical treatment as specified in Section 23 25 00. The system shall not be allowed to sit empty for any length of time.

5. When system water is clear, remove, clean and replace all strainers.

6. Water samples may be taken by the Architect/Engineer to verify a clean system. If system is not clean, the entire process, including chemical treatment specified in Section 23 25 00, shall be repeated at the Contractor’s expense.

7. Chemical cleaning applies to the following systems:
   a. Heating Water
   b. Chilled Water
   c. Glycol Water
   d. Heating/Cooling Water
   e. Condenser Water
3.4 INSTALLATION

A. General Installation Requirements:

1. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.

2. Install piping to conserve building space, and not interfere with other work.

3. Group piping whenever practical at common elevations.

4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

5. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.

6. Install bell and spigot pipe with bells upstream.

7. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

8. Branch takeoffs shall be from the top side (if branch is two sizes smaller than main), or any angle from the horizontal plane to the top of piping.

9. Contractor is responsible for the installation of all specialty items specified herein, pressure gauges, thermometers and other items as shown on the contract drawings.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment plus its required clearance space.

C. Valves/Fittings and Accessories:

1. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.

2. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.

3. Provide clearance for installation of insulation, and access to valves and fittings.

4. Provide access doors where valves are not exposed.

5. Where a manual balance valve is shown to be installed in series with a service (isolation) valve, separate balance and service (isolation) valves shall be installed.

6. Install balancing valves with the manufacturer's recommended straight upstream and downstream diameters of pipe.
7. Prepare pipe, fittings, supports, and accessories for finish painting.

8. Install valves with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.

9. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

10. Provide flanges or unions at all final connections to equipment, traps and valves.

11. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

3.5 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.

B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. **2-1/2" and larger fittings shall be long radius type**, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.

F. Use full and double lengths of pipe wherever possible.

G. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or pump.

H. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.

I. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.6 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate, and venting.
B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.

C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.

D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.

E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8” pipe shall connect the tapping location to a venting device in an accessible location.

F. All vent and drain piping shall be of same materials and construction as the service involved.

3.7 BRANCH CONNECTIONS

A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.

B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Use of forged weld-on fittings is also limited as follows:
   1. Must have at least same pressure rating as the main.
   2. Header or main must be 2-1/2” or over.
   3. Branch line is at least two pipe sizes under header or main size.

3.8 JOINING OF PIPE

A. Threaded Joints:
   1. Ream pipe ends and remove all burrs and chips.
   2. Protect plated pipe and valve bodies from wrench marks when making up joints.
   3. Apply Teflon tape to male threads.

B. Flanged Joints:
   1. Bronze flanges shall conform to B16.24 and ductile iron flanges to B16.42. Steel flanges shall be raised face except when bolted to flat face cast iron flange.
   2. Bolting shall be ASTM A307 Grade B with bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and B18.2.2.
   3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
   4. Gaskets for flat face flanges shall be full-face type. Gaskets for raised faced flanges shall conform to requirements for "Group I gaskets" in ASME B16.5. All gaskets shall conform to ASME B16.21. Unless otherwise specified, gaskets shall meet the following requirements:
a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.

b. Maximum pressure rating of at least 250 psig.

c. Minimum temperature rating: -10°F.

d. Maximum temperature rating of at least 170°F for water and glycol solution systems operating 140°F and less.

e. Maximum temperature rating of at least 250°F for water and glycol solution systems operating above 140°F and up to 180°F.

C. Solder Joints:

1. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 Grade 95TA. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, to all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder flows to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.

2. Flux shall be non-acid type conforming to ASTM B813.

3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove composition discs and all seals during soldering if not suitable for 470°F.

D. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.

2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.

3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.

4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

E. Grooved Joints:

1. Grooved connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall have malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure increases the tightness of the seal. Couplings must be installation-ready style for quick installation and no more than two-piece housings.

2. All work, including pipe grooving, shall be accomplished in accordance with manufacturer's published instructions.
3. Final tightening of bolts shall be with a torque wrench to ensure equal tension in all bolts.

4. All fittings shall be provided by one manufacturer. Mixing fittings will not be acceptable.

5. A factory-trained manufacturer’s representative shall periodically visit the site for contractor training and to review the grooved joint installations.


F. Mechanical Joints:

1. Joints shall conform to ANSI/AWWA C104/A21.11. Gasket material shall be neoprene. The standard bolts and nuts of the pipe manufacturer shall be used and be coated at the factory with rust preventive lubricant after threading and tapping.

2. Final tightening of bolts shall be with a torque wrench for equal tension in all bolts.

3. All fittings shall be provided by one manufacturer. Mixing fittings will not be acceptable.

G. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer’s installation instructions.

2. Fully insert tubing into the fitting and mark tubing.

3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.

4. Joint shall be pressed with a tool approved by the manufacturer.

END OF SECTION
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SECTION 23 21 23
HVAC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. All pumps except where integral with a manufactured piece of equipment.
B. Pump controls where self-contained.

1.2 SUBMITTALS
A. Submit shop drawings under provisions of Section 23 05 00.
B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.
D. Submit motor data indicating compliance with Section 23 05 13.
E. Submit certification that pumps, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:
   1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 PUMPS - GENERAL
A. Statically and dynamically balance rotating parts.
B. Construction shall permit complete servicing without breaking piping or motor connections.
C. Pumps shall operate at 1750 rpm unless specified otherwise.
D. Pump connections shall be flanged, whenever available.
E. Heating pumps shall be suitable for 225°F water.
F. Motors shall comply with Section 23 05 13.

G. Pump impellers shall not have smaller diameters than those scheduled. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.

2.2 IN-LINE PUMP

A. Type: Centrifugal, single stage, close coupled in-line, back pullout design, suitable for horizontal or vertical operation.

B. Casing: Cast iron, rated for greater of 125 psi or 1.5 times actual working discharge pressure, flanged suction and discharge with gauge ports.

C. Impeller: Bronze or stainless steel, fully enclosed, dynamically balanced, keyed to shaft and secured with locknut.

D. Shaft: Steel or stainless steel.

E. Seals: Mechanical type with internal flushing rated for -20 to 225ºF and comprised of Buna elastomer, carbon primary ring, and ceramic stationary ring.

F. Seals: Mechanical type rated for -20 to 250ºF with EPR or EPT bellows and seat gasket, carbon primary ring, and silicon-carbide stationary ring.

G. Acceptable Manufacturers: Bell & Gossett, Taco, Aurora, Armstrong, Grundfos/Pearlless/PACO, Patterson, Weinman/Crane.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:
   1. Install all products per manufacturer's recommendations.
   2. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger pump suction and discharge pipes. Allow a minimum of 18" clearance for removal of suction diffuser.
   3. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
   4. Install on vibration isolators as scheduled on drawings.

B. In-Line Pumps:
   1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.
B. Valves.
C. Steam Piping System.
D. Steam Condensate Piping System.
E. Acoustical Lagging.

1.2 QUALITY ASSURANCE

A. Valves: Manufacturer’s name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
C. Regulatory Requirements: comply with the provisions of the following:
   1. ASME B 31.1 "Power 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.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store and protect piping to prevent corrosion and entrance of foreign matter.
B. Deliver and store valves in shipping containers with labeling in place.

1.4 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9 for the following pipe systems:
   1. Boiler external pipe systems that operate up to 15 psi.
   2. Non-boiler external pipe systems that operate up to 150 psi.
B. Conform to ANSI/ASME B31.1 for boiler external pipe systems that operate above 15 psi.
C. Refer to ANSI/ASME B31.1 and ANSI/ASME B31.9 for “boiler external piping” and “non-boiler external piping” definitions.

1.5 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 23 05 00 for required steam and steam condensate piping systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.
1.6 SUBMITTALS

A. Hydrostatic Test Report on Steam and Condensate systems shall be submitted by the contractor.

PART 2 - PRODUCTS

2.1 STEAM PIPING (0 TO 125 psig)

A. Design Pressure: 125 psig.
   Maximum Design Temperature: 353°F.

B. Piping - 2" and Under:
   4. Unions: 250 psi S - 500 psi WOG, black malleable iron, ground joint with brass seat.

C. Piping - 2-1/2" and Over:
   2. Joints: Butt welded or flanged.
   4. Flanges: 150 lb. forged steel, welding neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.

D. Shutoff Valves:
   1. Gate Valves:
      a. GA-1: 2" and under, 125 psi S @ 353°F, 300 psi WOG @ 150°F, screwed, bronze, rising stem, screwed bonnet. Crane #431, Hammond #IB641, Stockham #B122, Walworth #56, Milwaukee #1150, Watts #B-3210, NIBCO T-131.
      b. GA-2: 2-1/2" thru 12", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted, OS&Y. Crane #465-1/2, Hammond, Stockham #G623, Walworth, Milwaukee #F2885, Watts #F-503, NIBCO F-617-O.
   2. Ball Valves:
      a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats
and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:
1) Provide extended shaft for all valves in insulated piping.
2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

b. BA-1A: 2-1/2" and 3", 150 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

NOTES:
1) Provide extended shaft for all valves in insulated piping.
2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

E. Throttling/Shutoff Valves:

1. Globe Valves:
   a. GL-1: 2" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413, Watts #B-4010-T, NIBCO T-235-Y.
   b. GL-2: 2-1/2" thru 10", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #8906F, Milwaukee #F2981, Watts #F-501, NIBCO F-718-B.

F. Check Valves:

1. CK-1: 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319, Walworth #3406, Milwaukee #509, Watts #B-5000, NIBCO T-413-Y.
2. CK-6: 2-1/2" thru 12", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, all iron, horizontal swing. Crane #373-1/2, Hammond #IR1126, Stockham #G933, Walworth #8928-1/2F, Milwaukee #F2971, Watts #F-511-R, NIBCO F-918-Ng.
G. Strainers:

1. **ST-1**: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 400# WOG @ 150°F. Armstrong #CA1SC, Metraflex #TS, Mueller Steam Specialty Co. #11M, Sarco #T, Watts #77S, NIBCO T-751. Bronze body strainer 125# may be used as contractor option.

2. **ST-2**: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 353°F, 175 psi WOG @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co.#758, Sarco #CI-125, Watts #77F, NIBCO F-721.

2.2 CONDENSATE PIPING (0 TO 125 psig)

A. Design Pressure: 125 psig.
Maximum Design Temperature: 353°F.

B. Piping - 2" and Under:


4. Unions: 250 psi S - 500 psi WOG, black malleable iron, ground joint with brass seat.

C. Piping - All Sizes:

1. Tubing: Type K drawn temper seamless copper tube, ASTM B88.

2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430°F to 535°F. Braze, AWS A5.8, BCuP silver/phosphorus/copper alloy with melting range 1190°F to 1480°F.

3. Fittings: Cast Brass, ASME 16.18 or wrought copper solder joint, ASME B16.22.

D. Piping - 2-1/2" and Over:

1. Pipe: Extra strong black steel, beveled ends, ASTM A53.

2. Joints: Butt welded and flanged.


4. Flanges: 150 psi forged steel, welding neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Welding neck type shall be used wherever possible and shall have bore to match pipe. Flange face seal weld (backweld) is required for slip-on flanges.

E. Shutoff Valves:

1. Gate Valves:

   a. **GA-1**: 2" and under, 125 psi S @ 353°F, 300 psi WOG @ 150°F, screwed, bronze, rising stem, screwed bonnet. Crane #431, Hammond #IB641,
Stockham #B122, Walworth #56, Milwaukee #1150, Watts #B-3210, NIBCO T-131.

b. GA-2: 2-1/2" thru 12", 125 psi $S_{373}$, 200 psi WOG @ $150^\circ F$, flanged, iron body, bronze mounted, OS&Y. Crane #465-1/2, Hammond, Stockham #G623, Walworth, Milwaukee #F2885, Watts #F-503, NIBCO F-617-O.

2. Ball Valves:

a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with $470^\circ F$ melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

1) Provide extended shaft for all valves in insulated piping.

2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over $120^\circ F$, heating water piping over $120^\circ F$, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

b. BA-1A: 2-1/2" and 3", 125 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

NOTES:

1) Provide extended shaft for all valves in insulated piping.

2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over $120^\circ F$, heating water piping over $120^\circ F$, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

F. Throttling Valves:

1. Globe Valves:

a. GL-1: 2" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413, Watts #B-4010-T, NIBCO T-235-Y.

b. GL-2: 2-1/2" thru 10", 125 psi $S_{353}$, 200 psi WOG @ $150^\circ F$, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #8906F, Milwaukee #F2981, Watts #F-501, NIBCO F-718-B.
G. Check Valves:
   1. CK-1: 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319, Walworth #3406, Milwaukee #509, Watts #B-5000, NIBCO T-413-Y.
   2. CK-6: 2-1/2" thru 12", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, all iron, horizontal swing. Crane #373-1/2, Hammond #IR1126, Stockham #G933, Walworth #8928-1/2F, Milwaukee #F2971, Watts #F-511-R, NIBCO F-918-N.

H. Strainers:
   1. ST-1: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 400# WOG @ 150°F. Armstrong #CA1SC, Metraflex #TS, Mueller Steam Specialty Co. #11M, Sarco #IT, Watts #77S, NIBCO T-751. Bronze body strainer 125# may be used as contractor option.
   2. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 353°F, 175 psi WOG @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co. #758, Sarco #CI-125, Watts #77F, NIBCO F-721.

2.3 CONDENSATE RETURN - PUMPED (0 TO 100 psig)

A. Design Pressure: 125 psig.
   Maximum Design Temperature: 353°F.

B. Piping - 2" and Under:
   4. Unions: 250 psi S - 500 psi WOG, black malleable iron, ground joint with brass seat.

C. Piping - 2-1/2" and Over:
   1. Pipe: Extra strong black steel, beveled ends, ASTM A53.
   2. Joints: Butt welded and flanged.
   4. Flanges: 150 lb. forged steel, welding neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Welding neck type shall be used wherever possible and shall have bore to match pipe. Flange face seal weld (backweld) is required for slip-on flanges.

D. Shutoff Valves:
   1. Gate Valves:
      a. GA-1: 2" and under, 125 psi S @ 353°F, 300 psi WOG @ 150°F, screwed, bronze, rising stem, screwed bonnet. Crane #431, Hammond #IB641,
E. Throttling/Shutoff Valves:

1. Globe Valves:
   a. GL-1: 2" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413, Watts #B-4010-T, NIBCO T-235-Y.
   b. GL-2: 2-1/2" thru 10", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #8906F, Milwaukee #F2981, Watts #F-501, NIBCO F-718-B.

2. Check Valves:
   a. CK-12: 2" and under, 125 psi saturated steam, 250 psi WOG, screwed, bronze or iron body, bronze mounted, center guided silent type, metal-to-metal seat. Lunkenheimer #233, Mueller Steam Specialty Co. #203-BP.
   b. CK-14: 2-1/2" thru 12", 200 psi WOG, double disc wafer type, bronze or iron body, bronze trim, metal-to-metal or Viton seat, 316 SS shaft, Inconel 600 spring. Mission Duo Chek #12HPP (with Inconel springs), Muessco #71-AHB-K-W, Stockham #WG-976, NIBCO W-920-W.

G. Strainers:

1. ST-1: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 400# WOG @ 150°F. Armstrong #CA1SC, Metraflex #TS, Mueller Steam Specialty Co. #11M, Sarco #IT, Watts #77S, NIBCO T-751. Bronze body strainer 125# may be used as contractor option.
2. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 353°F, 175 psi WOG @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co.#758, Sarco #CI-125, Watts #77F, NIBCO F-721.

2.4 STRAINERS

A. Unless otherwise indicated, strainers shall have stainless steel screens with perforations as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Steam All Sizes</th>
<th>Condensate All Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strainer</td>
<td>1/32&quot;</td>
<td>3/64&quot;</td>
</tr>
</tbody>
</table>

B. Furnish pipe nipple with gate valve and threaded cap to blow down all strainer screens.

2.5 ACOUSTICAL LAGGING

A. Type A: Lagging shall be a loaded vinyl noise barrier, fiberglass scrim facing, and 1" thick quilted fiberglass decoupling layer. Lagging shall have a minimum STC of 28, and Class A
flammability (maximum 25/50) rating per ASTM E-84. Install lagging per manufacturer's recommendations.


B. Type B: Lagging shall be a loaded vinyl noise barrier, fiberglass scrim facing, and 2” thick quilted fiberglass decoupling layer. Lagging shall have a minimum STC of 30, and Class A flammability (maximum 25/50) rating per ASTM E-84. Install lagging per manufacturer’s recommendations.


C. Refer to drawings for acoustical lagging locations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Make connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems.

3.2 TESTING PIPING

A. Acceptance Testing: Perform hydrostatic tests on the steam and condensate piping in accordance with ANSI B 31.1 and as follows:

1. Notify Owners Representative 24 hours before required testing. All tests shall be conducted in the presence of the Owners Representative.

2. Flush system with clean water. Clean strainers.

3. Minimum test pressure shall be 150 PSIG.

4. Test pressure shall be held for 1 hour.

5. Test gauges shall be 4” min face, 0-160 PSIG, have a current calibration date within 1 year of the test date.

6. Prepare reports for all tests and required corrective action.

7. System shall be operated for a minimum of 24 hours to demonstrate to the Owner's Representative that system is complete and operational.

3.3 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, all loose dirt, scale, oil and other foreign matter on internal or external surfaces shall be removed by means
consistent with good piping practice subject to the approval of the Architect/Engineer's representative. Chips and burrs from machinery or thread cutting operation shall be blown out of pipe before assembly. Cutting oil shall be wiped from internal and external surfaces.

2. During fabrication and assembly, remove slag and weld spatter from both internal and external pipe joints by peening, chipping and wire brushing.

3. Notify the architect/engineer’s representative prior to starting any post erection cleaning operation in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer’s representative regarding specific procedures and scheduling. Arrange for proper disposal of cleaning and flushing fluids.

4. When the system is started up for the first time, discharge the condensate to drain per the boiler manufacturer’s recommendations or for 24 hours, whichever is more restrictive. Add domestic cold water to the drain at a sufficient rate to reduce the condensate temperature to a maximum of 140°F.

3.4 INSTALLATION

A. General Installation Requirements:

1. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

2. Install piping to conserve building space and not interfere with use of space, other work, or equipment.

3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

4. Slope steam piping 0.25” in 10 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.

5. Slope steam condensate piping 0.5” in 10 feet.

6. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply zinc rich primer to welds.

7. All high pressure steam and condensate piping systems shall conform to the requirements of ANSI B31.1.

8. All low pressure steam systems shall comply with ASME B 31.1.

9. Contractor is responsible for the installation of all specialty items specified herein, pressure gauges, thermometers and other items as shown on the contract drawings.

10. Branch connections shall be made with straight tees, reducing tees, threaded, or welded. Tap size of wellolet or threaded to be no more than 1/3 of the tapped pipe.

11. Flanges shall be flat face when mating with 125# class cast iron valves.

12. Make reductions in pipe sizes using eccentric reducer fitting installed with the level
13. **Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated.**

**B. Installation Requirements in Electrical Rooms:**

1. **Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.**

**C. Valves/Fittings and Accessories:**

1. **Provide clearance for installation of insulation and access to valves and fittings.**

2. **Provide access doors where valves and fittings are not exposed.**

3. **Provide drip trap assembly at low points and before control valves and pressure reducing valves.**

4. **Provide loop vents over trapped sections.**

5. **Prepare pipe, fittings, supports, and accessories for finish painting.**

6. **Provide drip legs as shown on the drawings, at low points, traps, and the base of all risers in steam, and condensate pipes. Unless otherwise shown, drip legs shall be full pipe size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, with a reducer and a 3/4"shutoff valve.**

7. **Install valves with stems upright or horizontal, not inverted.**

8. **Provide shutoff valves in supply and return to all equipment.**

9. **Install strainers in steam piping with the “wye” of the strainer to the side of the pipe in the horizontal plane to avoid pooling of condensate.**

### 3.5 PIPE ERECTION AND LAYING

**A.** Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.

**B.** All pipe, fittings, valves, equipment and accessories shall have factory applied identification sufficient to determine conformance with specified requirements.

**C.** Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.

**D.** During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of system. Use plugs, caps, blind flanges or other items designed for this purpose.
E. Run pipe straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and to provide needed flexibility in piping.

F. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise noted.

G. Provide flanges or unions at all connections to equipment traps and valves to facilitate dismantling.

H. Arrange piping and connections so equipment served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

I. Use full and double lengths of pipe wherever possible.

J. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size made only at control valve, pump, or trap.

K. Cut all pipe to exact measurement and install without springing or forcing.

L. Avoid creating, even temporarily, undue loads, forces or strains on valves, equipment or building elements with piping connections or supports.

M. Unless otherwise indicated, branch takeoffs shall be from top of mains or headers at either a 45º or 90º angle from the horizontal plane for steam pipes.

3.6 BRANCH CONNECTIONS

A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise indicated.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Branch connections from mains may be cut into black steel pipe using forged weld-on fittings:
   1. Steam.
   2. Condensate.

D. Use of forged weld-on fittings is further limited as follows:
   1. Must have at least same pressure rating as the main.
   2. Header or main must be 2-1/2" or over.
   3. Branch pipe is at least two sizes under main size.

3.7 JOINING OF PIPE

A. Threaded Joints:
   1. Screw threads shall conform to ANSI B2.1 "Pipe Threads".
   2. Ream pipe ends and remove all burrs and chips formed in cutting and threading.
3. Protect plated pipe and valve bodies from wrench marks.
4. Apply high temperature, anti-seize thread lubricant to male threads.

B. Flanged Joints:

1. Steel flanges shall conform to ANSI B16.5 "Steel Pipe Flanges and Flanged Fittings". Cast iron flanges shall conform to ANSI B16.1 "Cast Iron Flanged and Flanged Fittings". Steel flanges shall be raised face except when bolted to flat face cast iron flange.

2. Bolting for services up to 399°F shall be ASTM A307, Grade B bolts and heavy hexagonal nuts. Bolting for services from 400°F to 790°F shall be ASTM A193, Grade B-7 with Grade 24 hexagonal nuts. Bolts and nuts shall conform to ANSI B18.2.1 "Square and Hex Bolts" or B18.2.2 "Square and Hex Nuts".

3. Set flange bolts beyond finger tightness with an indicating torque wrench to insure equal tension in all bolts. Tighten bolts so those directly opposite are torqued in sequence.

4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
   a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
   b. Gaskets used in piping systems for saturated steam service shall be approved by manufacturer for use in saturated steam applications up to and including 150 psig.
   c. Gaskets used for superheated steam applications and for saturated steam systems with operating pressures greater than 150 psig saturated steam shall be of the spiral wound "chevron" metallic type with flexible graphite filler by the following manufacturers: Flexitallic (LS Style CG), TEADIT (Style 913), Garlock (Flexseal Style RW), Lamons (SpiraSeal Style WR), Leader (Style LG-13).
   d. Gaskets used for steam condensate service including, but not limited to, condensate return, boiler feedwater, and condensate transfer piping systems shall meet the following requirements:
      1) Maximum pressure rating of at least 2,000 psig.
      2) Maximum continuous temperature rating of at least 650°F.

C. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.

2. Furnish to the Owner's Representative prior to start of work certificates qualifying each welder.
3. The Owner’s Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.

4. Ends of pipe and fittings to be joined by butt welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

3.8 ACOUSTICAL LAGGING

A. Where indicated on drawings, completely wrap pipe with lagging and seal all joints airtight with tape recommended by the lagging manufacturer to prevent acoustical leakage at joints. Overlap lagging a minimum of 2” at any joint. Overlap lagging 2” at any wall, floor, or structural deck penetration to prevent acoustical leakage.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Steam Traps.
B. Sample Coolers.
C. Deaerators.
D. Safety Valves.
E. Steam Condensate Meters.
F. Steam-to-Steam Humidifier Generator.

1.2 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

B. Traps: Remanufactured traps are not acceptable.

1.3 REFERENCES

C. AHRI 460 - Standard for Commercial and Industrial Humidifiers.
D. ASTM A105 - Forgings, Carbon Steel, for Piping Components.

1.4 SUBMITTALS

A. Submit product data under provisions of Section 23 05 00. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.

B. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.

C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

D. Submit manufacturer's installation instructions.

E. Submit operation and maintenance data.

F. Submit certification that all steam and steam condensate specialties, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:

   1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Manufacturer shall provide special seismic certification per OSHPD CAN 2-1708a.5 with submittal. Submittals without certification will be returned and not reviewed.

PART 2 - PRODUCTS

2.1 STEAM TRAPS

A. Type T-1: Inverted bucket type with thermic vent, 250 psig rated, cast iron body, side inlet and outlet, and all internal components constructed of stainless steel and renewable inline. Provide a bi-metal air vent and strainer screen.

Acceptable Products (0-250 psig):
Armstrong Machine Works Series 800T
Spirax/Sarco Co., Inc. Type B
Hoffman Industrial Specialties Co. Series 600 T
Clark-Reliance Series 120

B. Type T-3: Float and thermostatic type, 125 psig rated, Class 30 cast iron body; balanced pressure thermostatic air vent; stainless steel valve seat, float, brass valve mechanism, and side inlet and outlet. balanced pressure thermostatic air vent made of stainless steel or monel bellows with stainless steel head and seat.

Acceptable Products (0-125 psig):
Armstrong Machine Works Type A
Hoffman Industrial Specialties Co. Series H, C, or X
Spirax/Sarco Co., Inc. Type FT
Clark-Reliance Type FT

2.2 SAMPLE COOLERS

A. 316 stainless steel tube to convey steam and condensate through 316 stainless steel heat exchanger housing. All components to be stainless steel.

B. Cooler shall be rated for 215 psig (tube side) and 145 psig (cooling water side).

C. Cooler shall be capable of cooling 100 ml/min. of 295°F steam or 330 ml/min. of 185°F condensate with 6 l/min. of 68°F water.

D. Route cooling water outlet piping to nearest floor drain and provide vacuum breaker at highest point of cooling water supply piping.

2.3 SAFETY VALVES

A. SV-2: (Steam Service) Spring loaded disc type with bronze, cast iron, or steel body (steel body is required above 250 psig or 406°F), lifting lever, stainless steel disc and nozzle, and side outlet. Capacities ASME certified and labeled for Section I for boilers over 15 psig, Section IV for boilers up to 15 psig, and Section VIII for unfired pressure vessels or downstream of pressure reducing valves. Provide bellows trim where needed to compensate for piping backpressure. Acceptable Manufacturers: Consolidated Series 1900 or 1900/P; Kunkle - Fig. 6030, 6252, 300, or 600; or Keckley - Type 40 or 301.

2.4 SAFETY SHUTDOWN VALVE

A. SSV-1: (Steam Service) Carbon steel (150#) or cast steel (125#) body and bonnet, ASTM A216. Cage guided stainless steel plug. Stainless steel seat and stem. Live-loaded PTFE V-ring packing. ANSI class IV shutoff. Maximum pressure drop equal to 10% of inlet pressure. Reverse acting (normally closed) spring and diaphragm type pneumatic actuator. Actuator shall be capable of fully closing valve with no more than 40 psi control air. Acceptable Manufacturers: Spence Boss Series D, Spirax Sarco KE Series, Armstrong Python 1100 Series, or approved equal. Provide with flanged ends in larger sizes or screwed ends with unions in smaller sizes.

B. HPS-1: High Pressure Switch (Manual Reset):

1. Single stage, adjustable, manual reset switch assembly and enclosure.
2. Diaphragm piston type pressure sensor.
3. Rated for pressure specified.
4. Electrical rating shall be 15 amps at 120 volts.
5. All wiring terminals, adjustments, and visual scales accessible from front of switch.
7. Repeatability: ± 1% of operating range.
8. High pressure switch setpoint to be 10 psi (adj.) above operating pressure.
9. Acceptable Manufacturer: ASCO SD or approved equal.

C. ASV-1: Three-Way Air Solenoid Valve:

1. Brass body; stainless steel core tube, core and plugnut, and core springs.
2. Watertight enclosure.
3. UL listed for general purpose valves.
4. Acceptable Manufacturers: ASCO 8320 or approved equal.

2.5 LOCK OUT TRIM

A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in steam, condensate, boiler feed water piping, and as indicated on the drawings.

2.6 STEAM DISPERSION HUMIDIFIERS

A. Humidifier: Steam separator type with full separation ahead of control valve with discharge through internal drying and silencing chambers, and distribution manifold.

B. Separating Chamber: Disengage and remove water droplets and particle matter larger than three micrometers at maximum capacity.

C. Integral Control Valve: Steam jacketed parabolic plug, capable of modulating flow of steam over entire stroke of operator.
D. Internal Drying and Silencing Chamber: Designed to receive steam at atmospheric pressure and be jacketed by steam at supply pressure, with stainless steel medium in silencing chamber.

E. Manifold shall provide uniform distribution over entire length and be jacketed by steam at supply pressure.

F. Manifold shall use horizontal steam distribution and condensate return headers with horizontal manifold tubes for steam injection into air stream.

G. Humidification system dispersion tube hot surfaces in the airstreams of ducts or air-handling units shall be insulated with a product with an insulating value of at least 2.0 maximum ‘K’ value at 75°F. Insulation product shall be closed cell, non-toxic, shall be highly resistant to UV light exposure, shall not absorb water or support microbial growth, and shall meet flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723. Insulation product shall remain stable (material shall not degrade, harden or crumble) when operated continuously at temperatures up to 300°F.

H. Provide full length stainless steel internal silencing screen.

I. Provide electronic modulating control.

J. Equip with interlocked temperature switch to prevent operation before start-up condensate is drained.

K. Provide galvanized steel rods to support distribution manifolds and mount in air system plenums.

L. Connect unit to steam supply. Provide shutoff valve, inlet strainer, and external inverted bucket steam trap.

M. Acceptable Manufacturers: Armstrong, Sarco, Dri-Steem, Pure Steam, Carel.

2.7 VACUUM BREAKER

A. Spring loaded type selected or adjusted for the minimum possible opening pressure, but never over 11” water gauge.

B. Rated for 150 psig and 366°F.


PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. General Installation Requirements:

1. Install specialties in accordance with manufacturer’s instructions.

2. Size traps to handle minimum of two and one-half times maximum condensate load of apparatus served, unless noted otherwise.

3. All traps shall be minimum 3/4” size.
4. Install traps with unions or flanges at both ends.

5. Provide shutoff valve and strainer at inlet, and check valve and shutoff valve at discharge of traps.

6. Provide minimum 10” long dirt pocket of same size as apparatus return connection between apparatus and trap.

7. Remove thermostatic elements from traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

B. Safety Valve:

1. Rate safety valves for maximum capacity of largest available trim for pressure reducing valve(s) or maximum capacity of bypass valve(s), whichever is larger, at maximum possible pressure upstream of pressure reducing valve. Set at maximum 20 percent above reduced pressure.

2. Terminate safety valves outdoors. Provide drip pan elbow with drain connection to nearest floor drain.

C. Humidifier:

1. Provide humidifiers with complete standalone control system. Control wiring associated with the humidifier and attached sensors is the responsibility of this Contractor.

2. Route humidifier steam hose or piping and provide traps per manufacturer’s instructions.

END OF SECTION
SECTION 23 31 00
DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Ductwork Reinforcement
B. Ductwork Sealants
C. Rectangular Ductwork
D. Round and Flat Oval Ductwork
E. Exposed Ductwork (Rectangular, Round, or Oval)
F. Flexible Duct
G. Acoustical Lagging
H. Leakage Testing
I. Ductwork Penetrations
J. Duct Cleaning

1.2 DEFINITIONS
A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.

B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.

1.3 COORDINATION DRAWINGS
A. Reference Coordination Drawings article in Section 23 05 00 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

B. Duct drawings shall be at 1/4" minimum scale complete with the following information:
1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.

2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.

3. Location and size of all duct access doors.

4. Room names and numbers, ceiling types, and ceiling heights.

5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.

C. IMEG will provide electronic file copies of ventilation drawings for contractor’s use if the contractor signs and returns an “Electronic File Transfer” waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.
PART 2 - PRODUCTS

2.1 GALVANIZED DUCTWORK

A. General Requirements:

1. Duct and reinforcement materials shall conform to ASTM A653 and A924.

2. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.

3. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.

4. Ductwork reinforcement shall be of galvanized steel.

5. Ductwork supports shall be of galvanized or painted steel.

6. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel attached to the bottom of ducts with spacing as required by SMACNA.

7. Aircraft cable and slip cable hangers are acceptable for ducts up to 18" ø. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork. Acceptable manufacturers are Gripple, Ductmate, Duro Dyne, or Architect/Engineer approved.

8. All fasteners shall be galvanized or cadmium plated.

2.2 DUCTWORK REINFORCEMENT

A. General Requirements:

1. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.

   a. Ducts must be over 18" wide.

   b. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.

   c. Tie rods must not exceed 1/2" diameter.

   d. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.3 DUCTWORK SEALANTS

A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30°F to +175°F and 2000-hour minimum UV resistance per ASTM G-53.
B. Pressure sensitive tape used for sealing ductwork shall be minimum 2.5-inch wide, listed and marked UL 181A-P, having minimum 60 oz/inch peel adhesion to steel, and service temperature range from -20°F to +250°F.

C. Where pressure sensitive tape is called for on drawings and specifications for sealing flexible ductwork, tape shall be minimum 2.5-inch wide, UL 181 B-FX listed, and marked tape having minimum 60 oz/inch peel adhesion to steel and service temperature range from -20°F to +250°F. Acceptable manufacturers include: Venture Tape 1581A, Compac #340, Scotch Foil Tape 3326, Polyken 339.

2.4 RECTANGULAR DUCT - SINGLE WALL

A. General Requirements:

1. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.

2. Transitions shall not exceed the angles in Figure 4-7.

B. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:

1. All ducts shall be cross-broken or beaded.

2. Snap lock seams are not permitted.

3. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:

   a. Type 1:

      1) **Description**: Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.

      2) **Usage**: Limited to 3,000 fpm and vane lengths 36” and under.

   b. Type 2:

      1) **Description**: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.

      2) **Usage**: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48” long.

   c. Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):

      1) **Description**: Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
2) **Usage**: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48” long.

d. Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.

e. Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.

f. Omitting every other vane is prohibited.

4. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. **Mitered elbows (with or without turning vanes) may not be substituted for radius elbows.** Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.

5. Rectangular branch and tee connections in ducts over 1” pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1” pressure class.

6. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.

7. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1” or less, round duct is 12” diameter or less, and the tap is not located between fans and TAB devices.

8. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.

9. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2” pressure class and must be less than 6” in length.

10. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.

a. Apply sealant to all inside corners. Holes at corners are not acceptable.

b. **Acceptable Manufacturers**: Ductmate Industries - 25/35/45, Nexus, Mez, or WDCI. Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer’s approval before any fabrication begins.
11. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
   
a. Apply sealant to all inside corners. Holes at corners are not acceptable.
   
b. Flanges shall be 24-gauge minimum (not 26 gauge).
   
c. Acceptable Manufacturers: Lockformer TDC, TDF, United McGill, or Sheet Metal Connectors. Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer’s approval before any fabrication begins.

2.5 RECTANGULAR DUCT – CLOSED CELL RIGID PANEL (FOR EXPOSED DUCT ON ROOF ONLY)

A. Furnish and install ductwork as shown on the drawings.

B. Duct Construction:
   
   1. Panel shall be manufactured of CFC-free closed cell rigid thermoset resin thermally bonded on both sides to a factory applied 0.001” aluminum foil reinforced with fiberglass scrim. Zero permeability water tight barrier. Thermal conductivity shall be no greater than 0.13 BTU.in/Hr.ft^2.°F. Standard panel is 30 mm thickness panel with R-8.1 Continuous rating of 185 degree F inside ducts or ambient temperature surrounding ducts.
   
   2. All duct liner shall be UL listed. Silicone adhesive (Interior only). UV stable 1000 micron high impact resistant titanium infused vinyl (exterior). Factory manufactured cohesive bonded strips duct connectors. Factory manufactured all aluminum grip flange.
   
   3. Ducts shall be fully factory manufactured. 90 degree mitered elbows shall have turning vanes. Fabricate duct segments in accordance with manufacturer’s written details. Designed and fabricated duct segments and fittings will be in accordance with SMACNA Duct Construction Standards latest edition. Duct shall be constructed to exceed requirements for snow and wing loads. Supports on straight runs of ductwork shall be positioned at centers not exceeding 13 feet for duct sections when fabricated in 13 foot length with duct girth less than 84”. Larger duct sizes and short segments with duct girth greater than 84” are to be supported at 8 foot centers or less.
   
   4. Acceptable Manufacturer: Thermaduct or approved equal.

2.6 ROUND AND FLAT OVAL SPIRAL SEAM DUCTWORK - SINGLE WALL

A. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
B. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.

C. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.

D. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.

E. Ductwork shall be suitable for velocities up to 5,000 fpm.

F. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.

G. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.

H. Ducts with minor axis less than 22” shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.

I. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.

J. Transverse Joint Connections:
   1. Crimped joints are not permitted.
   2. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
   3. Ducts and fittings larger than 36" shall have flanged connections.
   4. Secure all joints with at least 3 sheet metal screws before sealing.
   5. Slide-on flanges as manufactured by Ductmate Industries - SpiralMate, Accuflange, or Sheet Metal Connectors are acceptable. Self-sealing duct systems are also acceptable (Lindab, Ward “Keating Coupling”).

2.7 FLEXIBLE DUCT

A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.

B. Flame Spread/Smoke Developed: Not over 25/50.

C. Flexible duct shall have corrosion-resistant wire helix, bonded to an inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh.
D. Inner liner shall be airtight and suitable for 6” WC static pressure through 10” diameter and shall be airtight and suitable for 4” WC static pressure 12” through 16” diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. “R” value shall not be less than 4.0 ft²°F/hr/Btuh. Temperature range of at least 0-180°F. Maximum velocity of 4,000 fpm.

E. Usage:
   1. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36” in length.
   2. Connections to air inlets and outlets. Do not exceed 6'-0" in length.

F. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.

G. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.

2.8 ACoustical Lagging

A. Type A: Lagging shall be a loaded vinyl noise barrier, fiberglass scrim facing, and 1” thick quilted fiberglass decoupling layer. Lagging shall have a minimum STC of 28, and Class A flammability (maximum 25/50) rating per ASTM E-84. Install lagging per manufacturer’s recommendations.

B. Type B: Lagging shall be a loaded vinyl noise barrier, fiberglass scrim facing, and 2” thick quilted fiberglass decoupling layer. Lagging shall have a minimum STC of 30, and Class A flammability (maximum 25/50) rating per ASTM E-84. Install lagging per manufacturer’s recommendations.

C. Refer to drawings for acoustical lagging locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide openings in ducts for thermometers and controllers.

B. Locate ducts with space around equipment for normal operation and maintenance.

C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork. Supply ductwork shall be free of construction debris, and shall comply with Level “C” of the SMACNA Duct Cleanliness for New Construction Guidelines.  
E. Repair all duct insulation and liner tears.  
F. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.  
G. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.  
H. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.  
I. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.  
J. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.  
K. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible and the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, where applicable. Refer to Section 23 05 50 for seismic requirements.  
L. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by California Building Codes.  
M. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.  
N. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.  
O. Kitchen Grease and Dishwasher Ductwork:  
   1. All kitchen grease and dishwasher ductwork shall be installed with a continuous slope and grease tight welds on all seams and joints.  

3.2 DUCTWORK APPLICATION SCHEDULE

<table>
<thead>
<tr>
<th>USAGE</th>
<th>MATERIAL</th>
<th>PRESSURE CLASS</th>
<th>SEAL CLASS</th>
<th>INSULATION</th>
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<tr>
<td>Supply Duct from Fan to Terminal Air Boxes – Single Wall</td>
<td>Galvanized Sheet Metal - Rectangular</td>
<td>+3”</td>
<td>A</td>
<td>2” thick Type A (R=6.0) or 2” thick Type C (R=7.1)</td>
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<tr>
<td>Supply Duct from Fan to Terminal Air Boxes – Single Wall</td>
<td>Galvanized Sheet Metal - Spiral Seam Round</td>
<td>+3”</td>
<td>A</td>
<td>2” thick Type A (R=6.0) or 2” thick Type G (R=7.1)</td>
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<td>------------</td>
</tr>
<tr>
<td>Supply Duct from Fan to Terminal Air Boxes</td>
<td>Galvanized Sheet Metal w/Slide-On Flange System or Formed-on Flanges</td>
<td>+3&quot; (+6&quot;)</td>
<td>A</td>
<td>2&quot; thick Type A (R=6.0) or 2&quot; thick Type C (R=7.1)</td>
</tr>
<tr>
<td>Supply Duct from Fan to Terminal Air Boxes – Double Wall</td>
<td>Galvanized Sheet Metal (spiral seam round or rectangular)</td>
<td>+3&quot;</td>
<td>A</td>
<td>1&quot; thick Type E (R=3.7) 2&quot; thick Type E (R=7.4)</td>
</tr>
<tr>
<td>Exterior Supply Duct from Fan to Terminal Air Boxes – Double Wall</td>
<td>Closed Cell Ductwork</td>
<td>+3&quot;</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Exterior Supply Duct from Fan to Terminal Air Boxes – Single Wall with Aluminum Jacket</td>
<td>Closed Cell Ductwork</td>
<td>+3&quot;</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Supply Duct from Terminal Air Boxes to Outlets</td>
<td>Galvanized Sheet Metal - Rectangular</td>
<td>+2&quot;</td>
<td>A</td>
<td>1-1/2&quot; thick Type A (R=4.5)</td>
</tr>
<tr>
<td>Supply Duct from Terminal Air Boxes to Outlets</td>
<td>Galvanized Sheet Metal – Spiral Seam Round</td>
<td>+2&quot;</td>
<td>A</td>
<td>1-1/2&quot; thick Type A (R=4.5)</td>
</tr>
<tr>
<td>Constant Volume from Fan to Outlet</td>
<td>Galvanized Sheet Metal - Rectangular</td>
<td>+2&quot;</td>
<td>A</td>
<td>1-1/2&quot; thick Type A (R=4.5)</td>
</tr>
<tr>
<td>Constant Volume from Fan to Outlet</td>
<td>Galvanized Sheet Metal – Spiral Seam Round</td>
<td>+2&quot;</td>
<td>A</td>
<td>1-1/2&quot; thick Type A (R=4.5)</td>
</tr>
<tr>
<td>Return Duct</td>
<td>Galvanized Sheet Metal</td>
<td>-2&quot;</td>
<td>A</td>
<td>1&quot; thick Type C</td>
</tr>
<tr>
<td>Exterior Return Duct</td>
<td>Closed Cell Ductwork</td>
<td>-2&quot;</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>AHU Exhaust Air Duct</td>
<td>Galvanized Sheet Metal</td>
<td>+2&quot;</td>
<td>A</td>
<td>1&quot; thick Type C (R=3.6)</td>
</tr>
<tr>
<td>Relief/Exhaust Air Duct from fan to Exhaust Outlet</td>
<td>Galvanized Sheet Metal</td>
<td>+2&quot;</td>
<td>A</td>
<td>1-1/2&quot; thick Type A (R=4.5)</td>
</tr>
<tr>
<td>Outside Air Intake from Louver to Heating Coil</td>
<td>Galvanized Sheet Metal</td>
<td>-2&quot;</td>
<td>A</td>
<td>1 1/2&quot; thick Type B (R=6.0)</td>
</tr>
<tr>
<td>Mixed/Make-up Air Duct</td>
<td>Galvanized Sheet Metal</td>
<td>-2&quot;</td>
<td>A</td>
<td>1-1/2&quot; thick Type A (R=4.5) 2&quot; thick Type A (R=6.0)</td>
</tr>
<tr>
<td>Relief Air Louver to Backdraft Damper</td>
<td>Galvanized Sheet Metal</td>
<td>+2&quot;</td>
<td>A</td>
<td>1 1/2&quot; thick Type B (R=6.0) 1 1/2&quot; thick Type B (R=6.0)</td>
</tr>
</tbody>
</table>
### 3.3 DUCTWORK SEALING

**A. General Requirements:**

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.

2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.

3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.

4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer’s data sheet specifies other application methods or requirements.

**B. For Seal Class A ducts, all transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.**

### 3.4 TESTING

**A. Duct - 2" WG or Less (positive or negative):**

1. Systems shall not leak more than shown in Table 4-1 of SMACNA HVAC Air Duct Leakage Test Manual for Seal Class A.

2. Leak testing of these systems is not normally required for interior ductwork. However, leak tests will be required if, in the opinion of the Architect/Engineer, the
leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.

3. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.

4. Seal ducts to bring the air leakage into compliance.

5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

B. Duct - 3" WG and Above (positive or negative):

1. All new ductwork shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.

2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.

3. Seal ducts to bring the air leakage into compliance.

4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

C. Test procedure shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:

1. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.

2. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.

3. All joints shall be felt by hand, and all discernible leaks shall be sealed.

4. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.

5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.

6. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

7. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.

8. The required leakage class for Seal Class A, both round and rectangular ducts, shall be 4.
9. Positive pressure leakage testing is acceptable for negative pressure ductwork.

3.5 DUCTWORK PENETRATIONS

A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.

B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.

C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

3.6 DUCTWORK CLEANING

A. General:

1. This section applies to the cleaning of ductwork and HVAC system components.

2. The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA) or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.

3. The HVAC system cleaning contractor shall furnish all necessary equipment, materials, and labor to adequately perform the specified services.

4. The HVAC system cleaning contractor shall be capable of remediation of exposed damaged insulation in air handlers and/or ductwork requiring replacement.

5. Regulatory Requirements:

   a. Contractor shall submit to the Owner SDS for all chemical products proposed to be used in the cleaning process.

B. Perform the services specified here in accordance with current NADCA standards.

C. System Component Inspections and Site Preparations:

1. Prior to beginning any cleaning work, perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment needed. The cleanliness inspection should include air handling units, other air moving equipment, and ductwork. In systems with multiple air handling units, a representative sample of the units should be inspected.

2. Coordinate any system shutdowns with the Owner a minimum of 24 hours in advance of any needed shutdowns.

3. The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification, or other debris. Follow the Owner's infection control policy where contamination is suspected and/or where even small amounts of contaminant may be of concern.
4. Damaged system components found during the inspection shall be documented and brought to the attention of the Owner and Architect/Engineer.

5. Conduct a site evaluation, and establish a specific, coordinated plan detailing how each area of the building will be protected during each phase of the project.

D. HVAC System Cleaning Requirements:

1. Collect debris removed during cleaning and take precautions to avoid dispersing debris from cleaning operations outside the HVAC system.

2. Use HEPA filters if particulate collection equipment exhausts inside the building.

3. When particulate collection equipment exhausts outside the building, precautions shall be taken to locate the equipment downwind and away from all air intakes and other points of entry into the building.

4. Cleaning operations shall be undertaken only with particulate collection equipment in place, including adequate filtration to contain debris removed from the HVAC system.

5. Take measures to control odors, mist, and vapors during the cleaning process.

6. All HVAC system components must be visibly clean as defined in the NADCA Standards.

7. Volume dampers, control dampers, and other mechanical devices inside the HVAC system must have their positions marked prior to cleaning and, upon completion, must be restored to their marked positions.

8. Service Openings:
   a. Use existing service openings where possible.
   b. Create openings where needed. Seal openings per the original duct pressure and leakage classification after use.
   c. Closures must not significantly restrict or alter the system airflow.
   d. Closures must be insulated to prevent heat transfer and condensation.
   e. Openings must not compromise the structural integrity of the system.
   f. Openings shall conform to applicable NFPA and SMACNA standards, and NADCA Standard 05.
   g. Do not cut openings in flexible duct. Disconnect flexible duct at the ends as needed for proper cleaning and inspection.
   h. Clearly mark all service openings that can be reopened and mark their locations in the final report.

9. The Contractor may remove and reinstall ceiling sections for cleaning access. Conform to the Owner's infection control policy for ceiling removal and dust control.

10. Clean all connected inlets and outlets.
11. Air Handling Unit Cleaning (Unit Identification):
   a. Thoroughly clean supply, return, and exhaust fans. Clean fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies. Remove all visible surface deposits in accordance with NADCA Standards. Contractor shall:
      1) Clean all internal surfaces, components, coils (including fins), condensate pans, and drains.
      2) Assure that a suitable operative drainage system is in place prior to beginning washdown procedures. Take care not to wet any insulation during washdown.

12. Duct System Cleaning:
   a. Create service openings as needed for cleaning inaccessible areas.
   b. Mechanically clean all duct systems such that the systems are capable of passing NADCA cleaning verification tests.
   c. Seal all openings, grilles, diffusers, etc. in the system to be cleaned.
   d. Attach high-pressure vacuum unit to ductwork near fan. Do not exceed the negative pressure rating of ductwork.
   e. From farthest opening, work dirt from duct back to extraction point using compressed air, brushes, and scrapers.
   f. Do not damage lining or devices during cleaning. Replace any damaged material.

E. Cleaning Methods

1. Source Removal Cleaning Method:
   a. Clean the HVAC system using source removal mechanical cleaning methods designed to extract contaminants from the HVAC system and safely remove contaminants from the facility. Select source removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification and other specified tests included in this section. No cleaning method or combination of methods shall be used that could potentially damage the HVAC system or negatively alter the system integrity.
   b. Operate vacuum collection devices continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned. The vacuum collection device must maintain sufficient negative pressure in all areas being cleaned to contain debris and protect the indoor environment.
   c. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters, including hand-held vacuums and wet vacuums.
   d. All vacuum devices exhausting outside the facility shall be equipped with particulate collection devices including a washable cloth filter bag to
contain debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any codes or regulations.

e. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces such that debris may be safely conveyed to vacuum collection devices. Acceptable methods include those that will not potentially damage the integrity of the ductwork nor damage porous surface materials, such as liners inside the ductwork, or system components.

f. Exterior gas-fired vacuum collection equipment shall be located at least 20 feet away from the building.

g. Where vacuum collection hoses run into the building, the Contractor shall seal the opening airtight so dust from the collection equipment cannot re-enter the building.

h. Hoses for mechanical agitation devices should not enter the building in the same location as the vacuum hoses. Utilize a remote building opening for the tool entry location.

2. Coil Cleaning:

a. Any cleaning method may be used that renders the coil visibly clean and capable of passing NADCA Coil Cleaning Verification tests. Coil drain pans shall be subject to Non-Porous Surfaces Cleaning Verification. The drain for the condensate drain pan shall be operational. Cleaning methods shall not cause any appreciable damage to, displacement or erosion of, or inhibit heat transfer of the coil surface and shall conform to coil manufacturer recommendations when available. Coils shall be thoroughly rinsed with clean water.

3. Biocide Agents and Coatings:

a. Biocide agents shall only be applied if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified through testing.

b. Biocide agents shall only be used where the Owner agrees in writing that he/she accepts coating the contaminated materials instead of replacement.

c. Application of any biocide shall be performed after removal of surface deposits and debris.

d. When used, apply biocides and coatings in strict accordance with manufacturer's recommendations, including minimum surface thickness for effectiveness and the EPA registration listing.

e. Coatings shall be sprayed directly onto interior ductwork surfaces rather than “fogged” downstream onto surfaces. A continuous film must be achieved on the surface to be treated by the coating application.
F. Verification of Cleanliness:

1. The HVAC system cleaning contractor shall verify the cleanliness of the system, with help from the Owner.
2. Cleanliness of HVAC systems shall be verified immediately after mechanical cleaning, before application of any treatment or introduction of any treatment-related substance to the HVAC system (including biocides and coatings), and before the HVAC system is restored to normal operation.
3. The HVAC system shall be inspected visually. If no contaminants are evident, the system shall be considered clean. However, the Architect/Engineer and Owner reserve the right to require further verification of system cleanliness through Surface Comparison Testing or the NADCA vacuum test.
4. NADCA vacuum test analysis shall be performed by a qualified third party experienced in testing of this nature.
5. If visible contaminants are evident, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection at the Contractor's expense.
6. Verification of Coil Cleanliness:
   a. Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured or cataloged when the coil was first installed. If the original pressure drop is not known, the coil will be considered clean only if it is free of foreign matter or residue based on a thorough visual inspection.

G. Final Report:

1. At the conclusion of the project, the Contractor shall provide a report to the Owner and Architect/Engineer indicating the following:
   a. Success of the cleaning project as verified through visual inspection and/or gravimetric analysis.
   b. Areas of the system found to be damaged and/or in need of repair.
   c. Locations of service openings.

3.7 ACOUSTICAL LAGGING

A. Where indicated on drawings, completely wrap ductwork with lagging and seal all joints airtight with tape recommended by the lagging manufacturer to prevent acoustical leakage at joints. Overlap lagging 2" at any wall, floor, or structural deck penetration to prevent acoustical leakage.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manual Volume Dampers.
B. Backdraft Dampers.
C. Fabric Connectors.
D. Drip Pans.
E. Duct Access Doors.
F. Duct Test Holes.
G. Duct Silencers.
H. Remote Volume Control Devices.
I. Ultraviolet (UVC) Germicidal Lamps.

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 05 00.
B. Submit manufacturer's installation instructions.
C. Include UL ratings, California State Fire Marshal approval and NFPA 90A, dynamic ratings, leakage, pressure drop and maximum pressure data.
D. Submit certification that ductwork accessories will withstand seismic forces defined in Section 23 05 50. Include the following:
   1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME DAMPERS

A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.

E. Provide locking quadrant regulators on single and multi-blade dampers.

F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

2.2 BACKDRAFT DAMPERS

A. Gravity backdraft dampers, size 18 inches x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturer's standard construction.

B. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90º stop, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

C. Acceptable Models: Ruskin CBD4, Arrow 655, Safe-Air/Dowco BRL, Greenheck EM.

2.3 FABRIC CONNECTORS

A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.

B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.

C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.

D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.

E. All corners shall be folded, sealed with mastic and stapled on 1" centers.

F. Fabric connectors shall not be painted.

G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.

H. Acceptable Materials: Durodyne MFN-4-100, Vent Fabrics, Inc. "Ventglas", or Proflex PFC3NGA.

I. Fabric connectors exposed to sunlight and weather shall be as described above, except the coating shall be hypalon in lieu of neoprene.

J. Acceptable Materials: Durodyne "Duralon MFD-4-100", Vent Fabrics, Inc. "Vention", or Proflex PFC3HGA.
2.4 DRIP PANS

A. Install drip pans under all rooftop exhaust fans, intake hoods, exhaust hoods and other roof penetrations that do not have ductwork below them to intercept dripping water.

B. Drip pans shall be 22 gauge minimum cross-broken or reinforced sheet metal with 2" welded upturned lips.

C. Pans shall extend 6" in all directions beyond the opening and shall have the top of the lip located 25% of the maximum throat dimension below the opening.

D. Insulate interior of drip pan with 1" thick elastomeric foam insulation. Adhere foam to drip pan with standard foam adhesive.

2.5 DUCT ACCESS DOORS

A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.

B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.

C. Provide duct access door in all horizontal return ductwork at 20 foot intervals per NFPA 90A.

D. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

E. Access doors with sheet metal screw fasteners are not acceptable.

F. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.

G. Provide quantity of access doors such that two hands can fit inside ductwork to manually reset fire dampers. This will typically require one access door on the bottom and one access door on an accessible side of the duct for sizes 12x12 and smaller.

2.6 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.7 DUCT SILENCERS

A. Straight Silencer

1. All silencers shall be factory fabricated by the same manufacturer, except that ‘No-Loss” silencers (thicker than normal double-wall ducts) may be Contractor fabricated.

2. Duct silencers shall have length, air pressure drop, and self-generated sound ratings not to exceed the values scheduled on the drawings. Dynamic insertion ratings shall not be less than those scheduled on the drawings. Silencer inlet and
outlet dimensions must match the sizes on the drawings. Transitions are not acceptable unless shown on the drawings.

3. All silencer ratings shall be determined in accordance with the ASTM E477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

4. Silencers shall be constructed of galvanized steel, have 26 gauge minimum perforated interior (22 gauge for transitional silencers), be able to withstand 8" of positive and 4" of negative pressure, and shall have inorganic, bacteria, and fungus resistant glass fiber filler with not less than 5% compression. Silencers shall meet SMACNA standards for the duct pressure class specified.

5. Fiberglass cloth or other scheduled liners shall completely separate the media from the airstream. No-media silencers shall not contain absorptive packing of any kind.

6. Silencers shall not exceed 25/50 flame spread/smoke developed per ASTM E84, NFPA 255, or UL 723.

7. Acceptable Manufacturers: Vibro-Acoustics, VAW, United McGill, Semco, Ruskin Sound Control (Rink), Dynasonics, Price. All silencers shall be by the same manufacturer.

B. Elbow Silencer

1. All silencers shall be factory fabricated by the same manufacturer, except that “No-Loss” silencers (thicker than normal double-wall ducts) may be Contractor fabricated.

2. Duct silencers shall have length, air pressure drop, and self-generated sound ratings not to exceed the values scheduled on the drawings. Dynamic insertion ratings shall not be less than those scheduled on the drawings. Silencer inlet and outlet dimensions must match the sizes on the drawings. Transitions are not acceptable unless shown on the drawings.

3. All silencer ratings shall be determined in accordance with the ASTM E477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

4. Silencers shall be constructed of galvanized steel with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48 shall have at least two half splitters and one full splitter. Silencers shall be able to withstand 8" of positive and 4" of negative pressure, and shall have inorganic, bacteria, and fungus resistant glass fiber filler with not less than 5% compression. Silencers shall meet SMACNA standards for the duct pressure class specified.

5. Fiberglass cloth or other scheduled liners shall completely separate the media from the airstream. No-media silencers shall not contain absorptive packing of any kind.
6. Silencers shall not exceed 25/50 flame spread/smoke developed per ASTM E84, NFPA 255, or UL 723.

7. Acceptable Manufacturers: Vibro-Acoustics, VAW, United McGill, Semco, Ruskin Sound Control (Rink), Dynasonics, Price. All silencers shall be by the same manufacturer.

2.8 DUCTWORK ACCESSORY SEALANTS

A. Ductwork accessory sealants and adhesives shall conform to Section 23 31 00.

B. Adhesives and Sealants: All sealers, adhesives, and sealants shall comply with the low

2.9 ULTRAVIOLET (UVC) GERMICIDAL LAMPS

A. General:

1. Acceptable Manufacturers:
   a. Evergreen UV; American Ultraviolet CC Series; SterilAire DE Series; UltraViolet Devices Inc.; ALTRU V Products; UV Resources DEF Series.

2. Quality Assurance:
   a. Qualifications: UVC products shall be from an ISO 9001 manufacturer.
   b. Fixtures: Fixtures shall have been tested, listed, and labeled under any NRTL per UL Standards 153, 1598, and 1995.

3. Warranty:
   a. Fixtures shall be warranted to be free from defects for a period of three (3) years.
   b. Lamps shall be warranted to be free from defects for a period of one (1) year.

4. Provide plaque reading as follows: “UV lights on when cooling coil control valve is commanded to run and off when it is in heating mode”.

B. Design Requirements:

1. Irradiation: Install lamps and fixtures in a sufficient quantity and manner to provide symmetrical distribution of UVC across surface.

2. Intensity: The minimal UVC energy striking a surface shall be sufficient to provide minimum (not average) 2000 µW/cm² over the entire coil face.

3. Installation: Fixture rows shall be electrically terminated to factory-supplied junction box to meet UL and local electrical codes. Fixtures shall be mounted to irradiate the intended surface(s) as well as all available line of sight airstream by proper placement and incident angle reflection. Third-party irradiation and intensity calculations (modeling) shall determine fixture placement and energy distribution and shall be provided in the submittal if such placement is absent on the plans.
C. Equipment:

1. Fixtures shall be track or rail mounted to factory-supplied hardware to form horizontal rows that provide proper fixture support. Fixtures shall be equipped with UL-approved fixture-to-fixture mechanical and electrical connections for proper installation and coupling to A/C power from one end. Fixtures shall be capable of being mounted as shown on the plans.

2. When used for surface irradiation, the fixture assembly shall be designed and installed such that the sum of the lamp arc lengths in a row shall be equal to a minimum of 90% of the surface’s total width.

3. Fixtures shall be constructed of Type 304 stainless steel or aluminum. All integral parts of the fixture shall be self-contained.

4. Power supply shall be 120 VAC, 60 Hz.

5. Ballasts shall be high efficiency electronic, rapid start, with <20%THD. Lamps shall be 254nm non-ozone producing. Ballasts shall be matched to the lamp and designed to maximize UVC production. They shall be UL listed and labeled for use in airstreams of 45°F to 135°F. They shall produce the specified output as specified under Irradiation and Intensity at no more than 13 watts of power consumption for each square foot of treated, cross-sectional plane. Each lamp shall contain no more than 5 milligrams of mercury while producing the specified output at 500 fpm in temperatures of 45°F to 135°F. Useful lamp life shall be 9000 hours with no more than a 15% output loss at the end of one year of continuous use. Lamps shall be constructed with metal bases and shall not produce ozone. Horizontal style lamps shall be sealed for moisture protection and have watertight connections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.

2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.

3. Coordinate and install access doors provided by others.

4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".

5. Grease duct access doors shall be installed per approvals from manufacturer's ICC-ES Evaluation Report.

6. Provide duct test holes where indicated and as required for testing and balancing purposes.

B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on
drawings and as required for air balancing. Use splitter dampers only where indicated.

2. Provide ceiling access doors for manual volume dampers. When manual volume dampers are located above an inaccessible ceiling and an access door cannot be installed, provide a remote-controlled volume control device for operation of the damper. Coordinate location with the Architect/Engineer.

3. Grease duct volume dampers shall be continuously welded to duct and/or hoods so that system is liquidtight.

C. Fire Damper, Fire Smoke Damper, Smoke Damper:

1. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves and duct connections.

2. Provide ceiling access doors for smoke and/or fire dampers. Coordinate location with the Architect/Engineer.

3. Demonstrate resetting of fire dampers to authorities having jurisdiction and Owner's representative.

4. At fire dampers, smoke dampers and combination fire smoke damper where duct is:
   a. Internally insulated, exterior duct wrap shall be installed from the wall out to 1 foot from the wall. All edges shall be taped.
   b. Externally insulated, the exterior duct wrap shall extend up to the wall.

D. Drain Pan:

1. Drain pans shall be installed per ASHRAE 62.1.
   a. All drain pans shall be field tested under normal operating conditions to ensure proper drainage.
   b. Field testing of drain pans is not required if units with factory installed drain pans have been certified (attested in writing) by the manufacturer for proper operation when installed as recommended.

END OF SECTION
SECTION 23 34 23
POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Roof Exhaust Fans.
B. Rooftop Fan Curbs.

1.2 QUALITY ASSURANCE
A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
B. Sound Ratings: AMCA 301, tested to AMCA 300.
C. Fabrication: Conform to AMCA 99.

1.3 SUBMITTALS
A. Submit shop drawings per Division 1. Include product data on wall and roof exhausters, and ceiling and cabinet fans.
B. Provide multi-rpm fan curves with specified operating point clearly plotted.
C. Submit manufacturer's installation instructions.
D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
E. Submit certification that power ventilators, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:
   1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 ROOFTOP EXHAUST FAN - DIRECT DRIVEN
A. Fan Wheel: Centrifugal type, aluminum or composite with backward inclined or airfoil blades, statically and dynamically balanced.
   1. Fans will comply with AMCA Standard 210 and ASHRAE Standard 51.
B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.

C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.

E. Direct drive, motor mounted outside of air stream and ventilated with outside air.

F. Aluminum or brass bird screen. Plastic mesh will not be allowed.

G. Disconnect provided by Electrical Contractor.

H. Furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.

I. Mill aluminum finish.

J. Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.


L. Statically and dynamically balanced fans and shafts.

M. Shaft Bearings shall be grease-lubricated ball bearings selected for L10 = 200,000 hours.

N. Extend grease fittings extended to an accessible location outside the fan section.

O. Motors and fan wheel shall have fixed pitch sheaves.

P. Fan section shall be run-balanced at the factory at the scheduled RPM.

2.2 ROOFTOP FAN CURBS

A. Furnish and install prefabricated roof curbs for all rooftop fans.

B. Size curb to match the curb cap of fan.

C. Top of all curbs shall be at least 12" above the top of the roof. Increase curb height to allow for roof insulation.

D. Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer.

E. If called for in the drawings, curbs shall be of the sound attenuation type. Sound attenuation curbs shall reduce the fan sone rating by at least 40% and not decrease fan cfm more than 8% (which is accounted for in the scheduled fan cfm). Baffles shall be removable for access to the dampers.

F. 18-gauge galvanized steel construction.

G. Curb without cant.

H. Acceptable Manufacturers: Same manufacturer as the fan, Pate, RPS or Thy.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated lag screws to roof curb.

C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.

D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Single Duct Variable Air Volume Terminal Box.

1.2 REFERENCES
   A. NFPA 70 - National Electrical Code.
   C. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS
   A. Submit shop drawings under provisions of Section 23 05 00.
   B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
   C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.
   D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.
   E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
   F. Submit manufacturer's installation instructions.
   G. Submit certification that all air terminal units, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:
      1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
         a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
      2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE DATA
   A. Submit operation and maintenance data.
B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

A. All units shall have noise data certified in accordance with AHRI Standard 885-98 with 5/8” 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Acoustical considerations shall take priority over sizes noted in schedule.

2.2 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Minimum 22 gauge galvanized steel ARI certified. Fully lined with minimum 1”, minimum 1-1/2 pound density fiberglass insulation. Insulation shall be UL listed and meet NFPA 90A requirements.

B. All insulation in contact with the air stream shall be foil faced, UL listed and NFPA 90A approved.

C. Damper Blade: Minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

D. Damper Operators: Electronic, furnished and installed by TCC. Refer to Section 23 09 00 for additional information.

E. DDC Volume Controller: Electronic, furnished and installed by TCC. Boxes to be pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. Provide velocity and static sensor at inlet to box for use by unit controller. Boxes shall be set for maximum and minimum settings shown on the drawings. Refer to Section 23 09 00 for additional information.

F. Hot Water Coils: Copper tubes, aluminum fins, minimum 0.016” wall thickness, leak tested at 300 psig. Air pressure drop shall not exceed scheduled value. Provide access door or removable panel for access to the upstream side of the heating coil. Capacity shall be as scheduled on the drawings. Hot water control valve shall be by the TCC.

G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings.

H. Refer to control diagrams and notes on control drawings for complete sequence of control.

I. Terminal units shall use an “X” style of averaging velocity grid airflow sensor on the unit inlet. Single point type sensors are not acceptable.

J. When design maximum cooling airflow calculations are within 10% of the maximum cfm rating limit of a VAV terminal unit, the next larger inlet size unit shall be selected and installed.

K. The design maximum cooling airflow for interior spaces shall be based on 60°F entering air temperature in lieu of typical 55°F temperature.
L. VAV boxes shall be supplied without the manufacturer's controller. The controller/actuator will be supplied by the BAS vendor.


PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure. Do not support from adjacent ductwork.

E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.

F. Comb fins on coils to repair bent fins.

G. Insulate terminal air box reheat coils to prevent condensation. Tape insulation tight to box. Do not insulate the box itself to prevent interference with actuator, access panel and control panel.

3.2 ADJUSTING

A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION
SECTION 23 37 00
AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grilles and Registers.
B. Square Stepdown Cone Diffusers.
C. Louvers.

1.2 QUALITY ASSURANCE

A. Test and rate performance of air inlets and outlets per ASHRAE 70.
B. Test and rate performance of louvers per AMCA 500L-99.
C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 23 05 00.
B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.
C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.
D. Submit manufacturer's installation instructions.
E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.4 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.
B. Conform to ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 GRILLES AND REGISTERS

A. Reference to a grille means an air supply, exhaust or transfer device without a damper.
B. Reference to a register means an air supply, exhaust or transfer device with a damper.
C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.
D. All margins shall be compatible with ceiling types specified (including ‘Thin-Line’ T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention
of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

E. The capacity and size of the unit shall be as shown on the drawings.

F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to $10^{-12}$ watts with a 10 dB room effect.

G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.

H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.

I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.

J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.

K. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.


2.2 LOUVERS - FIXED - ALUMINUM

A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.

B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.

C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.

D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.

E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.

F. Contractor shall provide the General Contractor with the correct sizes and locations of all louvers required in masonry walls.

G. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.

H. Louvers shall be suitable for duct connection.


PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install items in accordance with manufacturers' instructions.

2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3. Install diffusers to ductwork with air tight connections.

4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.

5. Supply air diffusers in operating rooms (Class B and C surgery) shall be opened and cleaned before the space is used.

6. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.

B. Volume Damper:

1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Filters and Filter Media.
B. Side Access Filter Housings.
C. Activated Carbon Filters.
D. Filter Frames.
E. Filter Gauges.

1.2 QUALITY ASSURANCE

A. Filter media shall be tested under ANSI/UL 900 and labeled.
B. Provide all filters and filter banks by one manufacturer.

1.3 REFERENCES

A. ANSI/UL 586 - Test Performance of High Efficiency Particulate, Air Filter Units.
B. ANSI/UL 900 - Test Performance of Air Filter Units.
C. ASHRAE 26 - Guideline for Field Testing of General Ventilation Devices and Systems for
   Removal Efficiency In-Situ by Particle Size and Resistance to Flow.
D. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for
   Removing Particulate Matter.

1.4 SUBMITTALS

A. Submit shop drawings per Section 23 05 00. Include data on media, performance,
   assembly and frames.
B. Submit certification that all air cleaning devices, accessories, and components will
   withstand seismic forces defined in Section 23 05 50. Include the following:
   1. Basis for Certification: Indicate whether certification is based on actual test of
      assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without
         separation of any parts from the device when subjected to the seismic
         forces specified and the unit will be fully operational after the seismic
         event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and
      locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is
      based and their installation requirements.
1.5 EXTRA STOCK

A. Provide a total of three (3) sets of filters for all units.
   1. Provide clean filters in all units at time of installation.
   2. Provide clean filters in all units at project final completion after all interior finishes are complete.
   3. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

PART 2 - PRODUCTS

2.1 MEDIUM EFFICIENCY - DISPOSABLE - TYPE D

A. Non-woven cotton fabric, pleated media, disposable type with welded wire grid support bonded to the filter media.
B. Heavy duty, paper board frame with diagonal support members bonded to inlet and exit sides of each pleat. Bond frame to media periphery to eliminate air bypass.
C. 1" thick media with at least 2.3 square feet of media per square foot of face area. Maximum 0.25" WG initial resistance at 350 fpm face velocity.
D. 25-30% efficiency and 90-92% arrestance per ASHRAE 52.1 or MERV 8 per ASHRAE 52.2.

2.2 95% EFFICIENT RIGID FILTER - DISPOSABLE - TYPE G

A. Pleated, rigid, disposable type with high density, fine fiberglass laminated to non-woven synthetic backing. Welded wire grid media support bonded to the filter media. Galvanized steel enclosing frame bonded to media periphery to eliminate air bypass.
B. Maximum 12" thick cartridges with at least 14.5 square feet of media per square foot of face area.
C. 90-95% efficiency and 99% arrestance per ASHRAE 52.1 or MERV 14 per ASHRAE 52.2. Maximum 0.65" WG initial resistance at 500 fpm face velocity.
D. Acceptable Manufacturers: Camfil, Flanders, American Air Filter.

2.3 SIDE ACCESS FILTER HOUSING

A. 16 gauge welded galvanized steel construction with bracing and prepunched standing flanges on inlet and outlet.
B. Full size, hinged access doors on each end of housing with 16 gauge galvanized steel, reinforced, positive sealing heavy duty latches and resilient gasketing.
C. 16 gauge galvanized steel or extruded aluminum holding tracks. "U" shaped bearing channel. Replaceable woven pile seals for filters.
D. Holds nominal 24" x 24" or 24" x 12" filters without alteration.
E. Filter channel suitable for 1" or 2" thick prefilter and bag or cartridge type final filters.

F. Acceptable Manufacturers: Camfil, American Air Filter, Flanders.

2.4 FILTER GAUGES

A. Inclined Manometer: One-piece molded plastic with epoxy coated aluminum scale, inclined-vertical indicating tube and built-in spirit level, 0-2" WG range, 3% of full scale accuracy.

B. Accessories: Static pressure tips with integral compression fittings, 1/4" plastic tubing, 2- or 3-way vent valves, indicating fluid.

C. Acceptable Manufacturers: Dwyer "Mark II", Meriam Instrument.

[***** O R *****]

D. Differential Pressure Gauge: Diaphragm actuated, nominal 3" round dial, glass filled nylon housing, polycarbonate lens, zero adjustment, 0-2" W.G. range, 5% of full scale accuracy.

E. Accessories: Static pressure tips with integral compression fittings and 1/8" NPT plastic tubing.

F. Acceptable Manufacturers: Dwyer "Minihelic II" 2-5000, Marshalltown Instrument “Series 85C”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturers' instructions.

B. Seal filter media to prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan systems without filters.

D. Install static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and calibrate. Every filter bank, including packaged units, shall have a filter gauge.

E. Install four (4) high efficiency filter test holes. Two upstream and two downstream, at all high efficiency filter banks in air handling units and ductwork (85% efficiency and higher). Coordinate location of test holes with Owner.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Modular Indoor Handling Units.

1.2 QUALITY ASSURANCE

A. AHU Unit: Manufacturer specializing in design and manufacturing of the products specified in this section with a minimum of five years’ experience.

B. Fabrication: Conform to AMCA 99 and AHRI 430.

C. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

D. Sound Ratings: Tested to AMCA 300.

E. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.

F. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.

G. Unit shall contain only UL listed components.

H. Conform to ASHRAE 90.1.

I. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 SUBMITTALS

A. Submit shop drawings per Section 23 05 00. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

1. Product Data

a. Provide fan curves with specified operating point clearly plotted. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops.

b. Submit sound power level data for both fan outlet and casing radiation at rated capacity.

c. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
d. Submit manufacturer’s data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.

e. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.

B. Submit manufacturer’s installation instructions.

C. All base bid pricing shall be based on the drawings, schedules and this specification

1. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices on the bid form. These voluntary prices will not be used in determining the low bidder.

2. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Architect/Engineer prior to the award of the air handling unit bid and before the submittal process begins.

D. Any exceptions to the specifications must be clearly noted to the Architect/Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.

G. Submit certification that modular air handing units, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.
1.5 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.
   B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.6 WARRANTY
   A. Provide a manufacturer’s 1-year parts and labor warranty against defects in material and workmanship.

1.7 GENERAL DESCRIPTION
   A. Unit Location:
      1. The air handling unit (AHU-11) is a variable air volume modular unit, located in a conditioned mechanical room on the second floor.
      2. The unit will be set on a concrete housekeeping pad by the Contractor.
   B. Building Type:
      1. The building is a steel structure with a cast-in-place concrete floor system on steel wide flange beams. (AHU-11)
   C. Unit Description:
      1. The unit shall contain all the components described in these specifications and shown on the drawings and schedules.
      2. Refer to air handling unit drawings and schedules for additional information

PART 2 - PRODUCTS

2.1 MODULAR INDOOR AIR HANDLING UNITS
   A. Acceptable Manufacturers
      1. Trane – “PSCA” Series.
      2. Daikin.
      3. Carrier.
      5. Air Flow Equipment.
      6. Ventrol.
      7. Temtrol.
   B. Housing:
      1. Minimum 18 gauge G60 galvanized steel exterior panels reinforced and braced with galvanized steel framework.
      2. Removable access panels for coil and fan removal.
3. Unit shall be double wall insulated constructed panel. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel. Cover all portions of the interior of the unit exposed to the airstream with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor is responsible for covering exposed insulation with galvanized sheet metal. The minimum R-value of the panel assemblies shall be 8.

4. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8” per foot.

5. Units shall be draw-thru or blow-thru as noted on the drawings and shall not exceed the overall dimensions.

6. Provide unit with an 8” base rail.

C. Doors:

1. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls.

2. Doors shall contain a continuous neoprene bulb type gasket.

3. Each door shall contain a double pane tempered, reinforced or safety glass window.

4. Each door shall have a minimum of two (2) high compression type latches, operable from both sides.

5. Unit shall have full height, galvanized, double wall, and hinged, removable access doors on both sides of fan.

D. Access Sections:

1. Provide access sections as shown on the drawings between unit sections. Provide access doors as shown on plans.

2. Fan section shall be run-balanced at the factory at the scheduled RPM.

3. Provide a service light in all accessible sections and the fan cabinet.

E. Fan:

1. Fans will comply with AMCA Standard 210 and ASHRAE Standard 51.

2. Double width, double inlet, centrifugal.

3. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type. Substitution of BI or BIA fans for FC is acceptable if efficiency is not lower.
4. Statically and dynamically balanced.

5. Grease lubricated ball bearings, selected for 200,000 hours L-50 life at the design operating conditions.

6. Provide extended lubrication lines for all bearings to an easily accessible location.

7. Provide approved belt guards with openings for tachometer readings for external drives only.

8. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.

9. Fan(s) shall have internal spring isolators.

10. Multiple fan arrays shall be provided with gravity backdraft dampers on each fan inlet.

11. Statically and dynamically balanced fans and shafts.

12. Fan shaft shall be solid steel, turned, ground, and polished. Fan wheels shall be keyed to the shaft. Shafts to be designed for 80% of first critical harmonic.

13. Extend grease fittings extended to an accessible location outside the fan section.

14. Fan section shall be run-balanced at the factory at the scheduled RPM.

15. An allowance of 1.5 inches or manufacturers recommended maximum, whichever is higher, Static Pressure for dirty filters shall be added to the internal static pressure calculation before fan selection.

16. Fan Drive shall have an OSHA compliant guard.

F. Motors and Drives:

1. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.

2. Motor mounting bracket shall be adjustable to allow tightening of belts.

3. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.

4. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 05 13.
   a. Motors will be designed to operate continuously at all speeds with variable speed drives having carrier frequency of 12 KHZ or higher without large fluctuations in amps drawn at any single speed.

5. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. On units over 20 HP, use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.

6. No equipment shall be selected or operate above 90% of its motor nameplate rating.
7. Motor Construction: Open, drip-proof, NEMA Standard MG 1, general purpose, continuous duty, Design B, insulation class H.

8. Motor shall not operate within the service factor range.

9. Premium efficiency motors are required.

10. Indicate the full identification of manufacturer, ratings, characteristics, construction, and special features.

G. Coils

1. Hot Water Coils:
   a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
   b. Suitable for continuous operation at 200 psi. Maximum air velocity of 1000 fpm.
   c. Galvanized steel casing. Coil headers and U-bends shall not be exposed.
   d. AHRI rated with 0.0005 fouling factor.
   e. Size coils sized based on EWT, EAT, gpm and cfm as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.
   f. Maximum 10 fins per inch. Maximum 8 rows.
   g. Turbulators are not permitted. Turbulators shall be allowed if removable headers are specified.
   h. Coils shall have drain and vent connections at supply and return headers with valves. Extend valving outside of the unit casing.
   i. Install coils level to allow drainage.
   j. Minimum 0.025" tube wall thickness. 5/8" O.D. minimum diameter
   k. Acceptable Manufacturers: Trane, York, Carrier, Marlo, Daikin, Heatcraft, or American Air Filter.
   l. Provide a double wall, internally insulated, sloped stainless steel drain pan under each coil including piping and header.

2. Chilled Water Coils:
   a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
   b. Stainless steel casing. Coil headers and U-bends shall not be exposed.
   c. Maximum air velocity of 450 fpm.
   d. AHRI rated with 0.0005 fouling factor.
e. Coils shall be sized based on EWT, EAT, gpm and cfm as scheduled. The leaving DB, leaving WB, APD and WPD shall not exceed the scheduled values.

f. Maximum 10 fins per inch. Maximum 8 rows. No water carryover shall occur at design airflow and no anti-carryover coating shall be used.

g. Suitable for 200 psig operation.

h. Coils shall have drain and vent connections at supply and return headers. Install coils level for proper drainage. Coils shall be completely drainable. Minimum 5/8” OD tubes. Minimum 0.025” tube wall thickness.

i. Provide a double wall, internally insulated, sloped stainless steel drain pan under each coil including piping and header.

H. Pre-Filter Section:

1. Provide side-loading particulate pre-filter section located downstream of return fan module as scheduled on drawings. Filter module shall be equipped with framing for 2” deep MERV-8 pleated media filters. Provide pre-filter module with full height hinged access door.

2. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.

3. Reference Section 23 40 00 for filter requirements.

I. Final Filter Section:

1. Provide front-loading final filter section located downstream of supply fan module as scheduled on drawings. Filter module shall be equipped with framing for 12” deep cartridge filters with seals on all four sides where each filter is inserted in the frame to prevent air bypass. Provide final filter module with full height hinged access door.

2. Maximum final filter face velocity shall not exceed 400 feet/minute.

3. Reference Section 23 40 00 for filter requirements.

J. Ultraviolet Germicidal Irradiation (UVGI):

1. Provided and installed by unit manufacturer. Refer to Section 23 33 00 for requirements.

2. Portal: The UV lamp plenum area shall be equipped with a viewing port for viewing the lamp assembly. Portal shall be constructed to allow viewing without the possibility of exceeding the Minimal Erythermal Dose.

3. Interlock: Include all interlocks and wiring to assure UV light assembly is not energized when any access door is opened. Provide lockout tagout switches to turn off UV lamps when persons are in the unit. Signage shall indicate CAUTION: ULTRAVIOLET ENERGY IN DUCT. DO NOT OVERRIDE THE SAFETY DEVICE OR OTHERWISE ACTIVATE LAMPS WITH DOOR OPEN.
4. Location: System shall be installed a minimum of 8 inches and maximum of 20 inches from coil surface (based on UVC manufacturer’s calculations and recommendations.) Install on tracks allowing the UV fixture to slide into place. Tracks shall be designed so the UV fixtures can be easily maintained and replaced. Interlock all UV lamps to turn on and off together.

K. Electrical Power:

1. Provide factory-mounted, vapor-tight light fixtures in each accessible section of the unit. The fixture shall be complete with junction box, globe, aluminum globe guard, switch, and bulb. Lighting shall be wired to a single 120-volt point, terminating at a designated junction box mounted on the air-handling unit. The Mechanical Contractor is responsible to complete all wiring connection between shipping splits after assembly. All wiring within the unit is to be contained within conduit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements

1. Install per manufacturer’s instructions.

2. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.

3. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.

4. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Coil Requirements:

1. Comb all coils to repair bent fins.

2. Extend coil drain and vent connections to outside unit housing. Provide normally closed valve on drain and vent connection outside of unit housing.

3.2 MANUFACTURER’S FIELD SERVICES

A. Provide factory authorized field representative for starting unit and training operator.

B. Prepare and start systems with installing contractor observation.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Modular Outdoor Air Handling Units.

1.2 QUALITY ASSURANCE

A. AHU Unit: Manufacturer specializing in design and manufacturing of the products specified in this section with a minimum of five years’ experience.

B. Fabrication: Conform to AMCA 99 and AHRI 430.

C. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

D. Sound Ratings: Tested to AMCA 300.

E. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.

F. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.

G. Unit shall contain only UL listed components.

H. Conform to ASHRAE 90.1.

I. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 SUBMITTALS

A. Submit shop drawings per Section 23 05 00. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

1. Product Data

a. Provide fan curves with specified operating point clearly plotted. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops.

b. Submit sound power level data for both fan outlet and casing radiation at rated capacity.

c. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
d. Submit manufacturer’s data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.

e. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.

B. Submit manufacturer’s installation instructions.

C. All base bid pricing shall be based on the drawings, schedules and this specification

1. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices on the bid form. These voluntary prices will not be used in determining the low bidder.

2. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Architect/Engineer prior to the award of the air handling unit bid and before the submittal process begins.

D. Any exceptions to the specifications must be clearly noted to the Architect/Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.

G. Submit certification that modular air handing units, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.

B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.6 WARRANTY

A. Provide a manufacturer’s 1-year parts and labor warranty against defects in material and workmanship.

1.7 GENERAL DESCRIPTION

A. Unit Location:

1. The air handling unit (AHU-4) is a constant volume modular unit, located on the roof.

2. The unit will be set on structural steel by the Contractor.

B. Building Type:

1. The building is a steel structure with a cast-in-place concrete floor system on steel bar joists. (AHU-4)

C. Unit Description:

1. The unit shall contain all the components described in these specifications and shown on the drawings and schedules.

2. Refer to air handling unit drawings and schedules for additional information

PART 2 - PRODUCTS

2.1 MODULAR OUTDOOR AIR HANDLING UNITS

A. Acceptable Manufacturers:

1. Trane
2. Daikin
3. Carrier
4. York
5. Air Flow Equipment
6. Ventrol
7. Temtrol

B. Housing:

1. Minimum 18 gauge G90 galvanized steel exterior panels reinforced and braced with galvanized steel framework.

2. Removable access panels for coil and fan removal.
3. Unit shall be double wall constructed and insulated in all sections. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel. Cover all portions of the interior of the unit exposed to the airstream with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor is responsible for covering exposed insulation with galvanized sheet metal. The minimum R-value of the panel assemblies shall be 8.

4. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8” per foot.

5. Units shall be draw-thru or blow-thru as noted on the drawings and shall not exceed the overall dimensions.

6. Provide unit base to allow unit to set on top of rooftop curb. Seal entire length and width under base to create a weather tight seal between the curb and the unit.

7. The external surface of the unit shall be factory painted to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Unit casing shall be prepared and coated with a minimum of 1.5 mil enamel finish.

8. The unit’s roof shall be double wall constructed. The inner roof shall be installed in such a manner to prevent air bypass between internal components. The outer roof shall be sloped a minimum of 0.25” per foot either from one side of the unit to the other, or from the center to the sides of the unit. All seams shall be gasketed and capped to prevent water infiltration. The roof assembly shall have a drip seal that overhangs all the walls of the unit.

9. Provide unit with a full length, continuous, base rail channel. Base rail channels shall be formed of a minimum 12 gauge galvanized steel. Support all major components from base rail.

10. Provide unit with a 36” roof curb.

C. Doors:

1. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls.

2. Door shall have a protective flange to shield gasket from exposure. Door frame shall be mounted on raised door frame and shall channel water away from gasket.

3. Doors shall contain a continuous neoprene bulb type gasket.

4. Each door shall contain a double pane tempered, reinforced or safety glass window.

5. Each door shall have a minimum of two (2) high compression type latches, operable from both sides.
6. Unit shall have full height, galvanized, double wall, and hinged, removable access doors on both sides of fan.

D. Access Sections:
1. Provide access sections as shown on the drawings between unit sections.
2. Unit sections with access doors shall be provided with floors capable of supporting maintenance personnel.
3. Provide a service light in all accessible sections and the fan cabinet.

E. Fan:
1. Double width, double inlet, airfoil/backward inclined centrifugal.
2. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type. Substitution of BI or BIA fans for FC is acceptable if efficiency is not lower.
3. Statically and dynamically balanced.
4. Grease lubricated ball bearings, selected for 200,000 hours L-50 life at the design operating conditions.
5. Provide extended lubrication lines for all bearings to an easily accessible location.
6. Provide approved belt guards with openings for tachometer readings for external drives only.
7. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.
8. Fan(s) shall have internal spring isolators.
9. Multiple fan arrays shall be provided with gravity backdraft dampers on each fan inlet.
10. Fans will comply with AMCA Standard 210 and ASHRAE Standard 51.
11. Statically and dynamically balanced fans and shafts.
12. Fan shaft shall be solid steel, turned, ground, and polished. Fan wheels shall be keyed to the shaft. Shafts to be designed for 80% of first critical harmonic.
13. Extend grease fittings extended to an accessible location outside the fan section.
14. Fan section shall be run-balanced at the factory at the scheduled RPM.
15. An allowance of 1.5 inches or manufacturers recommended maximum, whichever is higher, Static Pressure for dirty filters shall be added to the internal static pressure calculation before fan selection.
16. Fan Drive shall have an OSHA compliant guard.
F. Motors and Drives:

1. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.
2. Motor mounting bracket shall be adjustable to allow tightening of belts.
3. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.
4. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 05 13.
   a. Motors will be designed to operate continuously at all speeds with variable speed drives having carrier frequency of 12 KHZ or higher without large fluctuations in amps drawn at any single speed.
5. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. On units over 20 HP, use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
6. No equipment shall be selected or operate above 90% of its motor nameplate rating.
7. Motor Construction: Open, drip-proof, NEMA Standard MG 1, general purpose, continuous duty, Design B, insulation class H.
8. Motor shall not operate within the service factor range.
9. Premium efficiency motors are required.
10. Indicate the full identification of manufacturer, ratings, characteristics, construction, and special features.

G. Coils:

1. Hot Water Coils:
   a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
   b. Suitable for continuous operation at 200 psi. Maximum air velocity of 1000 fpm.
   c. Galvanized steel casing. Coil headers and U-bends shall not be exposed.
   d. AHRI rated with 0.0005 fouling factor.
   e. Size coils sized based on EWT, EAT, gpm and cfm as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.
   f. Maximum 10 fins per inch. Maximum 8 rows.
   g. Turbulators are not permitted. Turbulators shall be allowed if removable headers are specified.
Coils shall have drain and vent connections at supply and return headers with valves. Extend valving outside of the unit casing.

i. Install coils level to allow drainage.

j. Minimum 0.025" tube wall thickness. Minimum 5/8” O.D.

k. Provide a double wall, internally insulated, sloped stainless steel drain pan under each coil including piping and header.

l. Acceptable Manufacturers: Trane, York, Daikin, Carrier, Marlo Heatcraft, or American Air Filter.

2. Chilled Water Coils:

a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.

b. Stainless steel casing. Coil headers and U-bends shall not be exposed.

c. Maximum air velocity of 450 fpm.

d. AHRI rated with 0.0005 fouling factor.

e. Coils shall be sized based on EWT, EAT, gpm and cfm as scheduled. The leaving DB, leaving WB, APD and WPD shall not exceed the scheduled values.

f. Maximum 10 fins per inch. Maximum 8 rows. No water carryover shall occur at design airflow and no anti-carryover coating shall be used.

g. Suitable for 200 psig operation.

h. Coils shall have drain and vent connections at supply and return headers. Install coils level for proper drainage. Coils shall be completely drainable. Minimum 5/8” OD tubes. Minimum 0.025" tube wall thickness.

i. Provide a double wall, internally insulated, sloped stainless steel drain pan under each coil including piping and header.

H. Pre-Filter Section:

1. Provide side-loading particulate pre-filter section located downstream of return fan module as scheduled on drawings. Filter module shall be equipped with framing for 2” deep MERV-8 pleated media filters. Provide pre-filter module with full height hinged access door.

2. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.

3. Reference Section 23 40 00 for filter requirements.

I. Intake/Hood: Provide intake hood of same construction as main unit casing. The hood shall be sized for scheduled airflow.
J. External Pipe Cabinet:
   1. Provide external pipe cabinet spanning all coil and humidifier sections.
   2. Minimum cabinet depth shall be 31”.
   3. Pipe cabinet shall be supplied by the manufacturer.
   4. Pipe cabinet shall be factory assembled and shall be of the same construction as the main unit casing.
   5. The pipe cabinet shall be mounted externally and shipped loose to be field installed.
   6. Provide two (2) access doors. Each door shall be of the same construction as the unit doors and a minimum width of 20 inches.
   7. Provide lighting within pipe cabinet.
   8. Pipe cabinet to be heated.

K. Ultraviolet Germicidal Irradiation (UVGI):
   1. Provided and installed by unit manufacturer. Refer to Section 23 33 00 for requirements.
   2. Portal: The UV lamp plenum area shall be equipped with a viewing port for viewing the lamp assembly. Portal shall be constructed to allow viewing without the possibility of exceeding the Minimal Erythermal Dose.
   3. Interlock: Include all interlocks and wiring to assure UV light assembly is not energized when any access door is opened. Provide lockout tagout switches to turn off UV lamps when persons are in the unit. Signage shall indicate CAUTION: ULTRAVIOLET ENERGY IN DUCT. DO NOT OVERRIDE THE SAFETY DEVICE OR OTHERWISE ACTIVATE LAMPS WITH DOOR OPEN.
   4. Location: System shall be installed a minimum of 8 inches and maximum of 20 inches from coil surface (based on UVC manufacturer's calculations and recommendations.) Install on tracks allowing the UV fixture to slide into place. Tracks shall be designed so the UV fixtures can be easily maintained and replaced. Interlock all UV lamps to turn on and off together.

L. Electrical Power:
   1. Provide factory-mounted, weather-resistant (enclosed and gasketed), vapor-tight light fixtures in each accessible section of the unit. The fixture shall be complete with junction box, globe, aluminum globe guard, switch, receptacle, and bulb. Provide with factory-mounted outdoor service receptacles. Lighting and utility receptacles shall be wired to a single 120-volt point, terminating at a designated junction box mounted on the air-handling unit. The Mechanical Contractor is responsible to complete all wiring connection between shipping splits after assembly. All wiring within the unit is to be contained within conduits.
PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements

1. Install per manufacturer’s instructions.

2. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.

3. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.

4. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

5. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

B. Coil Requirements:

1. Comb all coils to repair bent fins.

2. Extend coil drain and vent connections to outside unit housing. Provide normally closed valve on drain and vent connection outside of unit housing.

3.2 MANUFACTURER’S FIELD SERVICES

A. Provide factory authorized field representative for starting unit and training operator.

B. Prepare and start systems with installing contractor observation.

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SECTION 23 81 26
SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Split system air conditioning wall units.

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 05 00.

B. Indicate drain, electrical, and refrigeration rough-in connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

D. Submit certification that split system air conditioning equipment, accessories, and components will withstand seismic forces defined in Section 23 05 50. Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Comply with manufacturer's installation instruction for rigging, unloading, and transporting units.

C. Protect units from weather and construction traffic by storing in dry, roofed location until units are ready for immediate installation.

1.4 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A for the installation of computer room air conditioning units.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.6 WARRANTY

A. Provide five (5) year manufacturer's warranty on all compressors.

PART 2 - PRODUCTS

2.1 SPLIT SYSTEM WALL AND CEILING-MOUNTED UNITS

A. Acceptable Manufacturers:

1. Carrier/Toshiba
2. Panasonic
3. LG
4. Sanyo
5. Samsung
6. Daikin Applied
7. Mitsubishi

B. Manufactured Units:

1. Provide packaged, air-cooled, factory assembled, pre-wired and pre-piped unit consisting of cabinet, fans, filters, remote condensing unit, and controls. Wall-mounted units shall be furnished with integral wall mounting bracket and mounting hardware.

2. Assemble unit for wall-mounted or ceiling installation with service access required.

3. Performance shall be as scheduled on the drawings.

4. Unit shall be rated per AHRI Standards 210/240 and listed in the AHRI directory as a matched system.

5. Provide unit with factory-supplied cleanable air filters.

6. The units shall be listed by Electrical Laboratories (ETL) in accordance with UL-1995 certification and bear the ETL label.

7. All wiring shall be in accordance with the National Electric Code (NEC).

C. Evaporator Cabinet and Frame:

1. Cabinet:

   a. Refer to schedule on drawings for mounting type (wall-mounted).

   b. Exposed units shall have a finished appearance with concealed refrigerant piping, condensate drain piping, and wiring connections.
D. Evaporator Fans and Motors:

1. Fans:
   a. The evaporator fan shall be direct drive with a single motor having permanently lubricated bearings.
   b. The fan shall be statically and dynamically balanced.
   c. The indoor fan shall have at least three speeds.

2. Motor:
   a. Direct driven, digitally controlled with multiple speeds. Permanently lubricated with internal overload protection.

E. Evaporator Coils (Direct Expansion):

1. Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins.
2. Single refrigeration circuit with externally equalized expansion valve.
3. Coils shall be pressure tested at the factory.
4. A sloped, corrosion-resistant condensate pan with drain shall be provided under the coil.

F. Electrical Panel:

1. Service Connections, Wiring, and Disconnect Requirements: Conform to the National Electrical Code and local electrical codes.

G. Control:

   a. The unit shall have a hard-wired 7-day programmable remote controller to operate the system. Provide wall mounting bracket for controller.
   b. Remote controller shall have “automatic”, “dry” (dehumidification), and “fan only” operating modes.
   c. The remote controller shall have the following features:
      1) **On/Off** power switch.
      2) **Mode Selector** to operate the system in auto, cool, heat, fan, or dehumidification (dry) operation.
      3) **Fan Setting** to provide multiple fan speeds.
      4) **Swing Louver** for adjusting supply louver discharge.
      5) **On/Off Timer** for automatically switching the unit off or on.
      6) **Temperature Adjustment** allows for the increase or decrease of the desired temperature.
      7) **Powerful Operation** to allow quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time.
d. The remote controller shall perform fault diagnostic functions that may be system related, indoor or outdoor unit related depending on the fault code.

e. Temperature range on the remote controller shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode.

f. The indoor unit microprocessor shall have the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote controller.

H. Outdoor Unit:

1. General:

 a. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be completely factory assembled and pre-wired with all necessary electronic and refrigerant controls.

2. Cabinet:

 a. The outdoor unit shall be fabricated of galvanized steel, bonderized and coated with a baked enamel finish for corrosion protection.

3. Fan:

 a. The fan shall be direct drive, propeller type fan with fan guard.
 b. Fan blades shall be statically and dynamically balanced.
 c. The fan shall have permanently lubricated type bearings.
 d. Motor shall be protected by internal thermal overload protection.
 e. Airflow shall be horizontal discharge.

4. Coil:

 a. The outdoor coil shall be nonferrous construction with corrugated fin tube.
 b. The coil shall be protected with an internal guard.
 c. Refrigerant flow from the condenser shall be controlled via a metering device.

5. Compressor:

 a. Hermetic or scroll refrigerant compressors with resilient suspension system, inverter driven, oil strainer, sight glass/moisture indicator, internal motor protection, high pressure switch, and crankcase heater.

 b. The outdoor unit shall have an accumulator and four-way reversing valve.

6. Refrigerant:

 a. Unit shall use R-410a.
 b. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

I. Integral Condensate Pump:

1. Packaged unit matched to evaporator unit including float switch, pump, motor assembly, check valve, and reservoir.
2. Provide alarm to indicate high level reservoir.

3. Unit shall be powered from evaporator unit with appropriate field connections available.

J. Refrigerant Piping:
   1. Design Pressure: 450 psig.
   2. Maximum Design Temperature: 250 F.
   3. Piping - 4" and under.
      a. Tubing: Type ACR seamless copper tube linesets, ASTM B1003. Sizes indicated are nominal designation.
      d. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged, and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

K. Piping – 1-3/8" and Under (Contractor’s Option):
   1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
   3. Fittings: Refrigerant grade copper in accordance with ASTM B75 or ASTM B743 with embedded HNBR O-ring.
   4. Acceptable Manufacturers: Parker Zoomlock

L. Piping – 1-3/8" and Under (Contractor’s Option):
   1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
   2. Joints: Mechanically attached connector, axially swaged compression connection.
   3. Fittings: Refrigerant grade copper in accordance with ASTM B75 or ASTM B743. Brass body with two stabilization inserts in accordance with ASTM B15/B16M, two steel rings in accordance with ASTM A108-13, anerobic adhesive sealant.
   4. Acceptable Manufacturers: Anvil Vulkan Lokring
   5. Refrigerant linesets are permitted.
      a. Provide manufacturer-packaged refrigerant linesets and accessories of sizes needed for installation. Verify lengths of piping required for installation.
6. Insulation:
   a. EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Minimum 1/2" thick for pipe sizes < 1-1/4" and 3/4" thick for pipe sizes 1-1/4" and above.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that proper power supply is available.

3.2 INSTALLATION
   A. General Installation Requirements:
      1. Install units in accordance with manufacturer's instructions. Install all units level and plumb. Indoor units shall be installed using manufacturer's standard mounting hardware securely fastened to building structure.
      2. Refer to Section 23 05 29 for roof support rails for outdoor unit.
      3. Coordinate the exact mounting location of all indoor and outdoor units with architectural and electrical work. Coordinate installation of ceiling-mounted units with ceiling grid layout. Provide additional ceiling grid reinforcement or modification as required and coordinate the work with the GC. Locate the indoor unit where it is readily accessible for maintenance and filter changes. Where outdoor units are located on the roof, locate at least 10' from the roof edge.
      4. Verify locations of wall-mounted remote controllers with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Height above finished floor shall not exceed 48”.
   B. Condensate Removal:
      1. Install condensate piping with trap and route from drain pan to nearest drain. Discharge to nearest code-approved receptor or to a properly vented indirect waste fitting. Flush all piping before making final connections to units.
   C. Comb all coils to repair bent fins.
   D. Install new filters in the unit at Substantial Completion.
   E. A factory-authorized service agent shall assist in commissioning the unit and inspecting the installation prior to startup. Submit startup report with O&M manuals.

3.3 REFRIGERANT PIPING
   A. Install refrigerant piping from the indoor unit(s) to the condensing unit. Refrigerant pipe sizes, lengths, specialties and configurations shall be as recommended by the manufacturer. Evacuate refrigerant piping and fully charge system with refrigerant per manufacturer's requirements.
B. Provide weather-tight insulated roof curb to accommodate refrigerant piping and conduit roof penetrations.

C. Insulate all refrigerant piping. Both liquid and suction lines shall be insulated between the indoor and outdoor units.

D. Joining of Piping:

1. **Brazed Joints:**
   a. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
   
   b. Flux shall conform to ANSI/AWS A5.31.
   
   c. Remove composition discs and all seals during brazing if not suitable for a minimum of 840°F.

2. **Mechanical Press Connection:**
   a. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
   
   b. Examination: Upon delivery to the jobsite, examine copper tubing and fittings for debris, defects, incise marks (manufacturer's engraving on tube), holes, or cracks.
   
   c. Fully insert tubing into the fitting and mark tubing.
   
   d. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
   
   e. Joint shall be pressed with a tool approved by the manufacturer.
   
   f. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

3. **Axially Swaged Connection:**
   a. Brass axially swaged connectors shall be installed in accordance with the manufacturer's installation instructions.
   
   b. Installers shall be trained by a certified Vulkan LOKRING trainer. Provide proof of certification upon request.
E. Insulation:

1. Insulate all refrigerant pipes between the heat pump and indoor units. This includes the liquid pipe, the suction pipe, the hot gas pipe, and the high/low pressure gas pipe. All fittings, valves, and specialty refrigerant components in the piping between the indoor and heat pump units shall also be insulated. The insulation shall have a continuous vapor barrier and shall pass through hangers and supports unbroken. All exterior insulated piping shall be painted with minimum of one (1) coat of UV resistant paint. Over size hangers and supports to allow the insulation to pass through unbroken. Following are the minimum insulation thicknesses unless noted otherwise in the manufacturer’s literature or required by local AHJ:

<table>
<thead>
<tr>
<th>Pipe System</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Refrigerant Suction</strong></td>
<td></td>
</tr>
<tr>
<td>(40°F &amp; Below)</td>
<td></td>
</tr>
<tr>
<td>Up to 1”</td>
<td>1/2”</td>
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<tr>
<td>1” and up</td>
<td>1”</td>
</tr>
<tr>
<td>(41°F to 60°F)</td>
<td></td>
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<tr>
<td>Up to 1-1/2”</td>
<td>1/2”</td>
</tr>
<tr>
<td>1-1/2” and up</td>
<td>1”</td>
</tr>
<tr>
<td><strong>Refrigerant Low Pressure Gas</strong></td>
<td></td>
</tr>
<tr>
<td>(141°F-200°F)</td>
<td></td>
</tr>
<tr>
<td>Up to 1-1/2”</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>1-1/2” and up</td>
<td>2”</td>
</tr>
<tr>
<td><strong>Refrigerant High Pressure Gas</strong></td>
<td></td>
</tr>
<tr>
<td>(201°F-250°F)</td>
<td></td>
</tr>
<tr>
<td>Up to 4”</td>
<td>2-1/2”</td>
</tr>
<tr>
<td><strong>Refrigerant Liquid</strong></td>
<td></td>
</tr>
<tr>
<td>Up to 1-1/2”</td>
<td>1”</td>
</tr>
<tr>
<td>1-1/2” and up</td>
<td>1-1/2”</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.

B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.

C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.

E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.

F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.

G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

3.2 PREPARATION

A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.
B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

C. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.

D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

E. Disconnect and remove abandoned panelboards and distribution equipment.

F. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.

G. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.

H. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.

I. All penetrations shall be x-rayed prior to cutting and/or drilling to avoid any tension cables or utilities encased in floor construction.

J. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means. Where conduit is in concrete slab, cut conduit flush with floor, pull out conductors, and plug conduit ends.

K. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
C. Luminaires: Remove existing luminaires for cleaning as required. Reinstall luminaire and connect to circuiting required.

D. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire
B. Cabling for remote control, signal, and power limited circuits
C. Fire rated and circuit integrity (CI) cable and assemblies

1.2 RELATED WORK

A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
B. NFPA 70 - National Electrical Code (NEC)
C. UL 44 – Thermoset-Insulated Wires and Cables
D. UL 83 – Thermoplastic-Insulated Wires and Cables
E. UL 1581 – Standard for Electrical Wires, Cables, and Flexible Cords
F. UL 2196 – Fire Resistant, Fire Resistant and Circuit Integrity Cables

PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.

B. Feeders and Branch Circuits Larger Than 6 AWG in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.

C. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600-volt insulation, THHN/THWN. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid or stranded conductor, unless otherwise noted on the drawings.

D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.

E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.

F. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.
2.2 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS:

A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer’s recommendations shall be followed.

1. Fire alarm
2. Building automation systems and control

B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60ºC, individual conductors twisted together, shielded, and covered with a PVC jacket.

C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60ºC, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60ºC, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.3 FIRE-RATED AND CIRCUIT INTEGRITY (CI) CABLE AND ASSEMBLIES

A. Properties and requirements of fire rated cables and assemblies:

1. 2HR fire rated for horizontal and vertical installations.

B. Acceptable fire-rated cables and listed assemblies:

1. Mineral Insulated Cables: Copper conductor, 600-volt insulation, rated 90ºC, Type MI.

2. MC Cable: Copper conductor, 600V thermoset, low smoke zero halogen silicone rubber insulation, continuously welded corrugated copper armor for equipment grounding conductor, rated 90ºC, UL listed 2196. MC fire rated cable shall not be used for branch circuits that required redundant equipment ground paths per code.

   a. Approved Manufacturer:

      1) VITALink MC
      2) Raychem Tycothermal MC

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings:

1. Building wire shall be installed in raceway.

B. All Other Locations: Building wire in raceway.

C. Above Grade: All conductors installed above grade shall be type “THHN”.
D. Underground or In Slab: All conductors shall be type “THWN”.

E. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.

F. Fire-Rated 2-Hour Feeders and Circuit Requiring Continuous Operation (CI): Refer to Part 2 of this section for acceptable products and assemblies. Installation shall meet UL 2196.

3.2 CONTRACTOR CHANGES

A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.15(B)(16) (formerly 310.16 for NEC 2008 and earlier).

B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.

C. Underground electrical duct ampacity rating shall be in accordance with NEC Table B.310.15(B)(2)(7) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.

D. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.

B. Use no wire smaller than 18 AWG for low voltage control wiring (<100 volts).

C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

D. Use no wire smaller than 8 AWG for outdoor lighting circuits.

E. The ampacity of multiple conductors in one conduit shall be derated per NEC 310. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

G. Splice only in junction or outlet boxes.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Make conductor lengths for parallel circuits equal.

J. All conductors shall be continuous in conduit from last outlet to their termination.

K. Terminate all spare conductors on terminal blocks and label the spare conductors.

L. Cables or wires shall not be laid out on the ground before pulling.

M. Cables or wires shall not be dragged over earth or paving.
N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.

O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.

P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.

D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.

E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.

F. Only nylon rope shall be permitted to pull cables into conduit and ducts.

G. Completely and thoroughly swab raceway system before installing conductors.

H. Conductor Supports in Vertical Raceways:

1. Support conductors in vertical raceways in accordance with NEC 300.19 and Table 300.19(A) Spacing of Conductors Supports.

2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.5 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Use suitable cable fittings and connectors.

C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer’s written instructions, applicable codes, the NECA’s “Standard of Installation”, recognized industry standards; and coordinated with other contractors.
D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.

E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

F. J-hook supports shall be installed at a maximum of five-foot (5’) intervals. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2” horizontal separation and 6” vertical separation between systems.

G. Open cable shall only be installed where specifically shown on the drawings or permitted in these specifications.

3.6 FIRE-RATED CABLE AND ASSEMBLY INSTRUCTIONS

A. Terminations of the fire-rated cable must be outside of the fire zone.

B. Fire-rated cable shall be installed according to the manufacturer’s instructions, recommendations, and UL listing.

C. Route fire-rated cable and assemblies separate from other feeders and distribution. Install cable and assemblies in locations protected from physical damage.

D. Refer to Electrical Identification Section 26 05 53 for specific identification requirements.

3.7 WIRING CONNECTIONS AND TERMINATIONS

A. Splice and tap only in accessible junction boxes.

B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.

C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.

D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.

F. Thoroughly clean wires before installing lugs and connectors.

G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:

   1. Facing the front and operating side of the equipment, the phase identification shall be:
      a. Left to Right - A-B-C
      b. Top to Bottom - A-B-C

J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.8 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.

C. MI cable shall have the insulation resistance of each cable tested with a 500-volt dc megohmeter prior to energizing the cables. Tabulate resistance values and submit to Architect/Engineer for acceptance.

D. Inspect wire and cable for physical damage and proper connection.

E. Torque test conductor connections and terminations to manufacturer's recommended values.

F. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

G. Provide documentation of the manufacturer's recommended lug torque value for copper, the date the lugs were torqued, and installed torque readings. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.

H. Protection of wire and cable from foreign materials:

   1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer’s performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
I. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and equipment supports
B. Fastening hardware

1.2 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 COORDINATION

A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Allied Support Systems
B. Cooper B-Line
C. Erico, Inc.
D. Hilti
E. Power Fasteners
F. Orbit Industries

2.2 MATERIAL

A. Support Channel: Hot-dip galvanized for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.

B. Hardware: Corrosion resistant.

C. Anchorage and Structural Attachment Components:

1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
   a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

3. Welding Lugs: Comply with MSS-SP-69, Type 57.

5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings and matched to the type and size of anchor bolts and studs used.

6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings and matched to the type and size of attachment devices used.

7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4” above roof.

2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.

3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.


PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.

D. Do not use powder-actuated anchors without specific permission.

E. Do not drill structural steel members.
F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

G. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

H. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

I. Refer to Section 26 05 33 for special conduit supporting requirements.

3.2 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION
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SECTION 26 05 33
CONDUIT AND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Rigid metallic conduit and fittings (RMC)
B. Electrical metallic tubing and fittings (EMT)
C. Flexible metallic conduit and fittings (FMC)
D. Liquidtight flexible metallic conduit and fittings (LFMC)
E. Wall and ceiling outlet boxes
F. Electrical connection
G. Pull and junction boxes

1.2 RELATED WORK

A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
   2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
   3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
   4. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
   5. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

B. Federal Specifications (FS):
   1. A–A–50553A – Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
   2. A–A–55810 – Specification for Flexible Metal Conduit

C. NECA “Standards of Installation”

D. National Electrical Manufacturers Association (NEMA):
   1. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

E. NFPA 70 – National Electrical Code (NEC)

F. Underwriters Laboratories (UL): Applicable Listings
   1. UL 1 – Flexible Metal Conduit
   2. UL 6 – Rigid Metal Conduit
   3. UL 360 – Liquid Tight Flexible Steel Conduit
   4. UL514-B – Conduit Tubing and Cable Fittings
5. UL797 – Electrical Metal Tubing
6. UL1242 – Intermediate Metal Conduit

G. Definitions:
1. Fittings: Conduit connection or coupling.
2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

PART 2 - PRODUCTS

2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Acceptable Manufacturers:

B. Minimum Size Galvanized Steel: 3/4 inch (19mm), unless otherwise noted.

C. Fittings and Conduit Bodies:
1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**

5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.2 **ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS**

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers of EMT Conduit: Allied, Calbond Calpipe, LTV, Steelduct, Wheatland Tube Co, or approved equal.

C. Fittings and Conduit Bodies:
   1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.
   2. Larger than 2": Compression type of steel designed for their specific application.

2.3 **FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS**

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.

B. Acceptable Manufacturers: American Flex, Alflex, Electri-Flex Co, or approved equal.

C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

D. Fittings and Conduit Bodies:
   1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron.
   2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
2.4 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Acceptable Manufacturers: Anaconda Type UA, Electri-Flex Type LA, Alflex, Carlon (Lamson & Sessions), or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:
   1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
   2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

2.5 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, minimum of 14 gauge, with 1/2-inch male fixture studs where required.

B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.

C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast feralloy, or stainless steel deep type, gasketed cover, threaded hubs.

D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.

2.6 [ECONN]: ELECTRICAL CONNECTION

A. Electrical connection to equipment and motors, sized per NEC. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.7 [JB]: PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.

B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

E. Flanged type boxes shall be used where installed flush in wall.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION SCHEDULE AND SIZING

A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the NEC shall be required.

B. The following schedule shall be adhered to unless they constitute a violation of applicable codes or are noted otherwise on the drawings. The installation of RMC conduit will be permitted in place of all conduit specified in this schedule.

<table>
<thead>
<tr>
<th>Installation Type</th>
<th>RMC</th>
<th>EMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeders: Switchboards, distribution panels, panelboards, motor control centers, etc.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Branch Circuits: Lighting, receptacles, controls, etc.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Mechanical Equipment Feeders: Pumps, chillers, air handling units, etc.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Floor Mounted Equipment Feeders: Pumps, etc. (include no more than 6 feet of LFMC to pump)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Controls (lighting, power, building automation, etc.)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Finished Spaces / Concealed</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Wet and Damp Locations: (conduit, boxes, fittings, installed and equipped to prevent water entry)</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Corrosive Locations

- Elevated Concrete Slabs (above grade) X
- Interior Locations: Concealed X
- Interior Locations: Exposed X

C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to NEC. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the NEC (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
D. **Minimum** Conduit Size (Unless Noted Otherwise):

1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)

2. Below Grade 5’ or less from Building Foundation: 1 inch.

3. Below Grade More than 5’ from Building Foundation: 1 inch.


E. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.

B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.

C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):

1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3” concrete cover.

2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.

D. Conduit shall not share the same cell as structural reinforcement in masonry walls.

E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4”=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer’s written instructions, applicable codes, the NECA’s “Standard of Installation”, in accordance with recognized industry standards, and coordinated with other contractors.

F. Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
G. Contractor shall cooperate with all Contractors on the project. He shall obtain details of other Contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.3 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.

F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.

G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the NEC requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the NEC requirements.
L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:

1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1” of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6” of finish floor and presents potential injury to personnel.

3.4 CONDUIT INSTALLATION

A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.

2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.

3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.

4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2” in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.

2. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.

   a. A third bend is acceptable if:

      1) The total run is not longer than (33) feet.
      2) The conduit size is increased to the next trade size.

3. Use conduit bodies to make sharp changes in direction (i.e. around beams).
D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the NEC.

2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.

3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.

4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5” below bottom of roof decking.

5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.

6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer’s recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal;

7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.

8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, equal to O-Z/Gedney type EYD.

9. Horizontal conduit routing through slabs above grade

a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3” min. concrete cover. Conduits shall run parallel to each other and spaced at least 8” apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1”.

b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.

c. No conduits are allowed to be routed horizontally through slabs above grade.

10. Do not route conduits across each other in slabs on grade.
11. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.

12. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.

3.5 CONDUIT TERMINATIONS

A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.

B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the NEC, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.

F. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.6 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8’ above the highest platform level.
3. Direct contact with concrete except slab on grade.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Exposed interior locations within 8’ of the highest platform level.
3. Direct contact with earth.
4. Direct contact with concrete in slab on grade.
5. Wet locations.
6. Kitchens and laundries when exposed on wall surface.
3.7 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.

D. Locate and install to maintain headroom and to present a neat appearance.

E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.8 OUTLET BOX INSTALLATION

A. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)

B. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.

C. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.

D. Provide knockout closures for unused openings.

E. Support boxes independently of conduit.

F. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

G. Install boxes in walls without damaging wall insulation.

H. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.

I. Position outlets to locate luminaires as shown on reflected ceiling drawings.

J. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

K. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

L. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
M. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.9 PULL AND JUNCTION BOX INSTALLATION
A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
B. Support pull and junction boxes independent of conduit.

3.10 EXPOSED BOX INSTALLATION
A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
F. Wood, plastic, or fiber plugs shall not be used for fastenings.
G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Seismic Requirements

1.2 QUALITY ASSURANCE
   A. General:
      1. The contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint and support system and perform seismic calculations in accordance with these specifications, state, and local codes.
      2. Items used for seismic restraint of equipment and systems shall be specifically manufactured for the purpose of seismic restraint.
      3. These requirements are beyond those listed in Section 26 05 27 of these specifications. Where a conflict arises between the seismic requirements of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

   B. Manufacturer:
      1. System Supports/Restraints: Company specializing in the manufacture of products specified in this Section.
      2. Equipment: Each company providing equipment that must meet seismic requirements shall provide certification included in project submittals the equipment supplied for the project meets or exceeds the seismic requirements of the project.

   C. Installer: Company specializing in performing the work of this Section.

   D. Suppliers: Following is a partial list of manufacturer/supplier contact information for seismic restraints:

1.3 REFERENCES
A. International Building Code, 2018
B. ASHRAE - A Practical Guide to Seismic Restraint
C. ASCE 7-05, Chapter 13

1.4 SUBMITTALS
A. Shop Drawings:
   1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located, experienced in seismic restraint design and installation, and licensed in the state where the project is located.
   2. Coordination Drawings: Plans and sections drawn to scale and coordinating fire protection systems and components with other systems and equipment in the vicinity for use in the development and layout of seismic bracing design.
   3. Manufacturer’s Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer’s certifications of compliance.
   4. System Supports/Restraints - Submit for each condition requiring seismic bracing:
      a. Sealed engineering calculations for each seismic brace and housekeeping pad details utilized on the project.
      b. Sealed plan drawings showing locations of seismic braces on contractor fabrication/installation drawings.
      c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
      d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.
   5. Equipment - Submit for each piece of equipment supplied:
      a. Certification that the equipment supplied for the project meets or exceeds the seismic requirements specified.
      b. Specific details of seismic design features of equipment.
      c. Sealed engineering calculations and details for equipment anchorage and support structure.
6. Coordination Drawings: Plans and sections drawn to scale, coordinating seismic bracing of mechanical components with other systems and equipment in the vicinity, including other seismic restraints.

B. A seismic restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If seismic restraints are not provided for a system that requires seismic bracing, the seismic designer shall submit a signed and sealed letter to the Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, utilized for each item. Seismic designer shall review system installation for general conformance to the exception requirements stated in the code and state, in writing, the system has been installed in accordance to the exception.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer’s instructions for storage.

1.6 PROJECT CONDITIONS

A. This project is subject to the seismic bracing requirements of the International Building Code, 2018 edition. The following criteria are applicable to this project:

1. Occupancy Category: IV
2. Seismic Design Category: C
3. Component Amplification Factors ($a_p$) and Component Response Modification Factors ($R_p$) shall be taken from Table 13.6-1 in ASCE 7-16 for the individual equipment or system being restrained.
4. Component Importance Factors ($I_p$) shall be taken from Section 13.1.3 in ASCE 7-16 for the individual equipment or system being restrained.
5. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

B. Forces shall be calculated with the above requirements and Equation 13.3-1, -2, and -3 of ASCE 7-16, unless exempted by 13.1.4.

C. Equipment shall meet International Building Code and ASCE 7 seismic qualification requirements in concurrence with ICC ES AC156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

1.7 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.
1.8 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.1 SEISMIC DESIGN CRITERIA

A. This section describes the requirements for seismic restraint of systems and equipment related to continued operation of the facility after a design seismic event.

B. Definitions

1. Stay in Place:
   a. All systems and equipment shall be anchored and restrained such that the anchoring system is intended not to fail and equipment and/or system components will not fall.

2. Remain Operational:
   a. Requirements for “Stay in Place” listed above shall be met.
   b. The following systems and associated equipment is intended not to fail externally or internally and is intended to remain operational.

   1) Life Safety Power
   2) Emergency Power System
   3) Fire Alarm

2.2 SEISMIC BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Seismic restraint designer shall coordinate all attachments with the Structural Engineer of Record.

2. The seismic restraint design shall be based on actual equipment data obtained from manufacturer’s submittals or the manufacturer. The equipment manufacturer shall verify and provide written certification the attachment points on the equipment can accept the combination of seismic, weight, and other imposed loads.

3. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.

4. Analysis shall detail anchoring methods, bolt diameter, embedment, and weld length.

5. All seismic restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized below.

B. Friction from gravity loads shall not be considered resistance to seismic forces.
C. Housekeeping Pads:

1. Reinforced housekeeping pads shall be provided to handle shear, tension, and compression forces with proper reinforcement, doweling, and attachments connecting the pad to the structural slab.

2. The seismic restraint designer shall design housekeeping pads.

2.3 SEISMIC RESTRAINT AND CONSTRUCTION OF EQUIPMENT

A. Equipment supplied for the project shall be designed to meet the requirements of lateral forces calculated using the applicable code and method described above.

B. Sealed engineering drawings indicating the specified seismic design criteria are met shall be provided in the equipment submittals.

C. The following is a partial list of equipment that shall be restrained and that shall be constructed to meet seismic forces described in this section:

1. Switchboards, Distribution Panelboards, Panelboards, Load Centers
2. Emergency Feeders
3. Transformers
4. Disconnect Switches
5. Magnetic, Manual, Combination Starters
6. Variable Frequency Drives
7. Automatic/Manual Transfer Switches
8. Interior Luminaires
9. Emergency Luminaires and Exit Signs
10. Fire Alarm Panel, Initiating and Notification Appliances
11. Nurse Call
12. Intercom, Sound System, Clock, TV Distribution
13. Security System

2.4 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.

2.5 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type. Comply with IBC, ACI and ICC ES requirements for cracked concrete anchors.
C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings and matched to the type and size of attachment devices used.

2.6 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A 570, GR 33.


3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.

4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.

1. Arrange units for attachment to the braced component at one end and to the structure at the other end.

2. Wire Rope Cable: Comply with ASTM 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

C. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the applicable code sections and Authority Having Jurisdiction for the exact seismic restraint requirements of piping, ductwork, conduit, equipment, etc.

B. Layout of transverse and longitudinal bracing shall follow recommendations of approved design standards listed in Part 1 of this specification section.
C. All rigid floor mounted equipment must have a resilient media between the equipment mounting hole and the anchor bolt in concrete.

D. All seismic restraint systems shall be installed in strict accordance with the manufacturer’s written instructions and all certified submittal data.

E. Installation of seismic restraints shall not cause any change in position of equipment lighting or conduits resulting in stresses or misalignment.

F. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

G. Do not install any equipment or conduit that makes rigid connections with the building unless isolation is not specified.

H. Coordinate work with all other trades to avoid rigid contact with the building. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect’s/Engineer’s attention prior to specific equipment selection.

I. Prior to installation, bring to the Architect’s/Engineer’s attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

J. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or International Code Council approved seismic anchors for installation in concrete.

K. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit.

L. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

M. Do not install cables over sharp corners.

N. Brace support rods when necessary to accept compressive loads. Welding of compression braces to the vertical support rods is not acceptable.

O. Provide reinforced clevis bolts when required.

P. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.

Q. Post-Installed anchors shall be provided to meet seismic requirements.

R. Vertical conduit risers flexibly supported to accommodate thermal motion and/or pipe vibration shall be guided to maintain pipe stability and provide horizontal seismic restraint.

S. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

T. Conduit crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the conduit, equipment connections, or support
connections. Conduit offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent conduit.

U. Do not brace a system to two different structures such as a wall and a ceiling.

V. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

W. Positively attach all roof mounted equipment to roof curbs. Positively attach all roof curbs to building structure.

X. Exposed seismic supports in occupied areas shall be guarded or covered to protect occupants.

3.2 SEISMIC RESTRAINT EXCLUSIONS

A. Refer to the applicable code sections and Authority Having Jurisdiction for allowable exclusions.

3.3 FIELD OBSERVATIONS

A. General conformance of seismic restraints of system components and equipment shall be field observed by the seismic designer and reported as properly installed.

B. The Contractor shall correct all deficiencies noted by the seismic designer.

C. A final observation and observation report by the seismic designer shall occur.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Adhesive labels, markings, nameplates, and signs
B. Wire and cable markers
C. Raceway, box, and wire identification
D. Equipment short circuit current rating (SCCR) labeling
E. Electrical equipment labeling

1.2 REFERENCES

B. NFPA 70 – National Electrical Code (NEC)
C. ANSI A13.1 – Standard for Pipe Identification
D. ANSI Z535.4 – Standard for Product Safety Signs and Labels

PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).

1. Label Size as follows:
   a. Raceways: Kroy or Brother labels 1-inch (25mm) high by 12-inches (305mm) long (minimum).

2. Color: As specified for various systems.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch (25mm) to 2 inches (50mm) in width.

C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pretensioned gripping action when coiled around the cable.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch (5mm) minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F (10°C to 176°C). Provide ties in specified colors when used for color coding.

F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
G. Aluminum, Wraparound Marker Bands: 1-inch (25mm) width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

H. Brass or aluminum Tags: 2” (50mm) by 2” (50mm) by .05-inch (2mm) metal tags with stamped legend, punched for fastener.

I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

2.2 NAMEPLATES AND SIGNS

A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch (2mm) minimum thick for signs up to 20 square inches (13 square cm), or 8 inches (200mm) in length; 1/8 inch (3mm) thick for larger sizes. Labels shall be punched for mechanical fasteners.

B. Baked–Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting ¼” grommets in corners.

C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch (10mm) galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4” grommets in corners.


E. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.3 PRODUCT COLORS

A. Adhesive Markings and Field Labels:
   1. All Labels: Black letters on white face
   2. Normal Power and General Labels: Black letters on white face
   3. Control Labels: Black letters on white face
   4. Medium Voltage (greater than 100 volts): Black letters on white face
   5. Fire Alarm: Red letters on white face
   6. Emergency: Red letters on white face

B. Nameplates and Signs:
   1. NORMAL POWER: Black letters on white face
   2. Control Labels: Black letters on white face
   3. EMERGENCY: White letters on red face
   4. GROUNDING: White letters on green face.
   5. CAUTION or UPS: Black letters on yellow face

C. Raceways and Conduit:
   1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
      a. Fire Alarm System: Red
      b. Temperature Controls: Blue
PART 3 - EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.

B. Install identification devices in accordance with manufacturer’s written instruction and requirements of NEC.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

D. Circuit Identification: Tag or label conductors as follows:

1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.

2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility’s electrical installations.

E. Apply warning, caution and instruction signs as follows:

1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch (10mm) high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

F. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
G. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

H. Install ARC FLASH WARNING signs on all power distribution equipment per Section 26 05 73.

3.2 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

A. Product:

1. Adhesive labels and field markings

B. Identification material to be a clear, 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

C. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. “C1A #24”).

3.3 BOX LABELING

A. Products:

1. Adhesive labels and field markings

B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

C. All junction, pull, and connection boxes shall be identified as follows:

1. For power and lighting circuits, indicate system voltage and identity of contained circuits (“120V, 1LA1-3,5,7”).

2. For other wiring, indicate system type and description of wiring (“FIRE ALARM NAC #1”).

3.4 CONDUCTOR COLOR CODING

A. Products:

1. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders, and branch circuits shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel in colors specified below. The tape shall be applied at each conductor termination with two 1-inch (25mm) tape bands at 6-inch (150mm) centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches (76mm) from the termination and spaced at 3- inches (76mm) centers. Tighten to a snug fit and cut off excess length.

D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

E. Conductors shall be color coded as follows:

1. 208Y/120 Volt, 4-Wire:
   a. A-Phase – Black
   b. B-Phase – Red
   c. C-Phase – Blue
   d. Neutral – White
   e. Ground Bond – Green

2. 480Y/277 Volt, 4-Wire:
   a. A-Phase – Brown
   b. B-Phase – Orange
   c. C-Phase – Yellow
   d. Neutral – Gray
   e. Ground Bond – Green

3. Grounding Conductors:
   a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.

4. Cabling for Remote Control, Signal, and Power Limited Circuits:
   a. Fire Alarm: Red.
   b. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.

3.5 CONTROL EQUIPMENT IDENTIFICATION

A. Products:
   1. Nameplates and signs

B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. Labeling shall include:
   1. Equipment type and contract documents designation of equipment being served.
   2. Location of equipment being served if it is not located within sight.
   3. Voltage and phase of circuit(s).
   4. Panel and circuit number(s) serving the equipment.
   5. Method of automatic control, if included (“AUTO CONTROL BY FCMS”).
6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.

7. Date of fault current study, refer to one-line diagram

![Diagram of Exhaust Fan EF-1](image)

**EXHAUST FAN EF-1**
  ("LOCATED ON ROOF")
  480V, 3-PHASE
  FED FROM "1HA1-1"
  AUTO CONTROL BY FCMS
  22,000 AMPS AVAILABLE FAULT CURRENT
  DATE OF STUDY: 1 JAN 2017

### 3.6 EQUIPMENT CONNECTION IDENTIFICATION

A. **Products:**
   1. Nameplates and signs

B. **Provide identification** for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.

C. **Identification shall be provided** for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. **Labeling shall include:**
   1. Equipment type and contract documents designation of equipment being served
   2. Location of equipment being served if it is not located within sight.
   3. Voltage and rating of the equipment.
   4. Panel and circuit numbers(s) serving the equipment
   5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
   6. Date of fault current study; refer to one-line diagram

![Diagram of Unit Heater UH-1](image)

**UNIT HEATER UH-1**
  ("LOCATED IN STORAGE ROOM 200")
  480V: 3-PHASE
  FED FROM "1HA1-1"
  22,000 AMPS AVAILABLE FAULT CURRENT
  DATE OF STUDY: 1 JAN 2017

### 3.7 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. **Products:**
   1. Nameplates and signs

B. **Provide identification** on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

IMEG #18004255.00  26 05 53 - 6
UM Women’s and Children's Hospital
Air Handling Unit Replacement
1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.

2. Exterior Equipment: The identification material shall be engraved vinyl labels.

3. Labeling shall include:
   a. Equipment type and contract documents designation of equipment.
   b. Voltage of the equipment.
   c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
   d. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").

   DISTRIBUTION PANEL DP-H1
   480Y/277V
   FED FROM SWITCHBOARD “SB-1” (LOCATED IN MAIN ELEC ROOM)

4. Provide the following on a separate label, installed below the label above:
   a. Available fault current; refer to one-line diagram or panel schedules
   b. Date of fault current study; refer to one-line diagram

   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

C. Nominal System Voltage Label:
   1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

D. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1").

E. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Low voltage distribution system power study.
B. Short-circuit analysis and report.
C. Arc-flash hazard analysis and report.

1.2 SUBMITTALS

A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections and shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.

B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths provided by the Electrical Contractor. IMEG will provide a preliminary Power Tools for Windows project file for information, if requested.

C. Documentation of the analyses shall be submitted in a bound booklet format and shall accompany the shop drawing submittals for equipment provided under the related work specification sections. These shop drawings will not be reviewed without this documentation.

D. Power system study project model shall be submitted on electronic media for review and the Owner’s operating and maintenance records.

1.3 RECORD DOCUMENTS

A. Provide two electronic copies on portable USB memory stick of the power system study to the Owner. One copy needs to be delivered to Marsha Smith at University of Missouri Healthcare Center and the other copy delivered to the Owner’s representative. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections and shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.

1.4 SCOPE

A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis and arc flash hazard analysis.

PART 2 - PRODUCTS

2.1 Power systems study shall be completed in Power Tools for Windows (PTW) 7.0 or later version.
PART 3 - EXECUTION

3.1 SHORT-CIRCUIT ANALYSIS

A. Provide a complete short-circuit analysis from the utility service to and including the entire building distribution as shown on the drawings.

B. Analysis shall include the entire distribution system from the point of connection to the utility power source to the distribution panels and branch circuit panelboards.

C. Documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted.

3.2 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts. Where the arc flash hazard/risk category is equal to or greater than level 3, the overcurrent protective device coordination study should be reviewed to reduce the hazard/risk level.

C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².

D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from ten per unit to three per unit after ten cycles).

G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

H. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.

I. Mis-coordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

J. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at two seconds based on IEEE 1584-2002 section.

K. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.

M. The label shall include the incident energy calculated in the analysis and the hazard category or appropriate personal protective equipment (PPE) required to perform maintenance on the system when energized. Labels shall be vinyl or laminated, with a self-adhesive backing.

N. Examples showing the minimum required information follow:

O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.
3.3 ADJUSTMENTS

A. Manufacturer’s authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study.

3.4 TRAINING

A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Device plates and box covers
B. Modular connectors
C. Receptacles

1.2 QUALITY ASSURANCE

A. Provide similar devices from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC Article 100, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
C. Comply with the NEC.

1.3 REFERENCES

A. DSCC W-C-896F – General Specification for Electrical Power Connector
B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
C. NEMA WD 1 – General Color Requirements for Wiring Devices
D. NEMA WD 6 – Wiring Devices – Dimensional Requirements
E. NFPA 70 - National Electrical Code (NEC)
F. UL 498 – Standard for Attachment Plugs and Receptacles
G. UL 943 – Standard for Ground Fault Circuit Interrupters

1.4 SUBMITTALS

A. Submit product data under provisions of Division 1.
B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.
C. Submit manufacturer occupancy sensor coverage patterns applicable to this project. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

PART 2 - PRODUCTS

2.1 DEVICE COLOR

A. All switch, receptacle, outlet, and coverplate colors shall be gray, unless indicated otherwise.
2.2 COVERPLATES

A. All switches, receptacles, and outlets shall be complete with the following:
   1. #302 stainless steel coverplates.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 05 53.

D. Plate securing screws shall be metal with head color matching the wall plate finish.

2.3 MODULAR CONNECTORS

A. Devices listed below are traditional wired devices. Contractor option to provide equivalent modular connector-type devices (Hubbell Snap Connect, Pass & Seymour Plug Tail, Leviton Lev-Lock, Copper ArrowLink) where applicable.

B. Wiring devices with modular wiring type quick connectors shall comply with the following in addition to the above:
   1. Wired with #12 THHN Cu, stranded or solid, 3 or 4 wire as required for device, minimum 6” lead length.
   2. Connector contacts shall be crimped or welded.

2.4 RECEPTACLES

A. Refer to Electrical Symbols List for device type.

B. [REC-DUP]: NEMA 5-20R Duplex Receptacle:
   1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap.
   2. Approved Manufacturers: Hubbell 5352, Leviton 5362-S, Pass & Seymour 5362, Cooper 5362.

C. [REC-DUP-GFI]: NEMA 5-20R Ground Fault Duplex Receptacle:
   1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
   2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.

D. [REC-DUP-WP]: NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:
   1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face. Provide NEMA 3R rated while-in-use clear cover.
   2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
3. Approved Manufacturers: Hubbell GFTR20/(RW57300) WP826, Leviton GFWT2/(5977-CL) M5979, Pass & Seymour 2097TRWR/(WIUC10-C) WIUCAST1, Cooper WRSGF20/(WIU-1) WIUMV-1.

E. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

F. Side wired devices shall have four binding screws that are undercut for positive wire retention.

G. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

2.5 WALL SWITCHES

A. Refer to Electrical Symbols List for device type.

B. [SW-1P]: Single Pole Switch:
   1. Single throw, 120/277 volt, 20 amp maintained contact. Toggle handle, side and back wired.
   2. Approved Manufacturers: Hubbell HBL1221, Leviton 1221-2, Pass & Seymour PS20AC1, Cooper AH1221.

2.6 PIN AND SLEEVE DEVICES

A. Industrial heavy-duty pin and sleeve devices shall comply with IEC 309-1.

B. [REC-#]: 600 volt, 30 amp, 3-phase, 3-wire Pin and Sleeve Simplex Receptacle:
   1. Provide with raintight, weatherproof, screw cap and chain.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.

B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.

C. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.

D. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
E. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

F. Install devices and wall plates flush and level.

G. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 05 53 - Electrical Identification.

H. Test receptacles and modular wiring connectors for proper polarity, ground continuity and compliance with requirements.

I. Healthcare devices shall be tested in accordance with NFPA 99 6.3.3 for grounding, voltage, and impedance measurements.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fuses
B. Spare Fuse Cabinet

1.2 REFERENCES

A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types
B. UL 198E - Class R Fuses
C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
D. NEMA FU 1 - Low Voltage Cartridge Fuses
E. NFPA 70 – National Electrical Code

1.3 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40°F or more than 100°F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – FUSES

A. Bussman, Division of Eaton
B. Edison Fuse, Division of Cooper Industries
C. Mersen
D. Littelfuse Inc

2.2 FUSES

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.
D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.
E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.
F. Control transformer fuses: Class CC (time delay).
G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses where indicated on the drawings and specifications.
B. Install fuses in accordance with manufacturer's instructions.
C. Install fuses in packaged equipment as required by equipment manufacturer.
D. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION
SECTION 26 28 16
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Fusible switches
B. Non-fusible switches

1.2 RELATED SECTIONS AND WORK
A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.3 REFERENCES
A. NEMA KS 1 - Enclosed Switches

1.4 SUBMITTALS
A. Submit product data under provisions of Section 26 05 00.
B. Product Data: For each type of enclosed switch, circuit breaker, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.5 COORDINATION
A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE AND NON-FUSIBLE SWITCHES
A. [FDS-#:] Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.

B. [DS-#:] Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: Type as indicated on the disconnect schedule.
D. Accessories: As indicated on the disconnect schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

END OF SECTION
SECTION 26 29 23
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Variable frequency drives [VFD-#]

1.2 RELATED SECTIONS AND WORK
   A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

1.3 REFERENCES
   A. ANSI/UL Standard 508
   B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
   G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

1.4 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Division 1.
   B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
   C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
   D. Test Reports: Indicate field test and inspection procedures and test results.
   E. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
F. Manufacturer's Field Reports: Indicate start-up inspection findings.

G. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers and describe operating limits that may result in hazardous or unsafe conditions.

H. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

I. Provide harmonic distortion analysis of total service to prove variable frequency drives proposed do not exceed the latest version of IEEE 519 voltage and current distortion limits as shown in Table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience and with service facilities within 200 miles of Project.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 EXTRA MATERIAL

A. Provide two of each air filter.

B. Provide three of each fuse size and type.

C. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept controllers on site in original packing. Inspect for damage.

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 in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Division 1.

B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

C. Operation Data: Include instructions for starting and operating controllers and describe operating limits that may result in hazardous or unsafe conditions.
D. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit's type and details.
   b. Nameplate legends.
   c. Short-circuit current rating of integrated unit.
   d. UL listing for series rating of overcurrent protective devices in combination controllers.
   e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Toshiba; Model Q9 or Model AS3: www.toshiba.com

B. ABB; Model ACH550: www.abb.com

C. Yaskawa; Model Z1000 www.yaskawa.com

2.2 DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.

1. Employ microprocessor-based inverter logic isolated from power circuits.

2. Employ pulse-width-modulated inverter system.

3. Include a DC link reactor for reduction of harmonic distortion.

4. The controller, and all associated components, shall be supplied by a single vendor.

5. The controller will be operating a variable volume fan motor, or water pump motor for HVAC application.

6. System voltage shall be indicated on front of ASD, using minimum of 1-inch high letters.
B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public. No disconnects in VFD cabinet. Disconnect must be in separate enclosure.

C. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The controller shall be suitable for use with standard NEMA B squirrel cage 1.15 service factor induction motors without requiring any modifications to the motor or the drive.

D. Controller shall have sufficient capacity to provide speed control of the motors shown or noted throughout the specified environmental operating conditions.

E. Controller shall have the functional components listed below:
   1. Door interlocked input circuit breaker/fused switch.
   2. Input rectifier section to supply fixed DC bus voltage.
   4. DC bus capacitors.
   5. Control transformer.
   6. Separate terminal blocks for power and control wiring.
   7. Terminal block for operator controls.
   8. Sine weighted PWM generating inverter section.

2.3 RATINGS
   A. Rated Input Voltage: Refer to Variable Frequency Drive Schedule.
   B. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule.
   C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
   D. Operating Ambient: 0°C to 40°C.
   E. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
   F. Minimum Elevation without Derating: 3300 feet.
   G. Minimum Efficiency at Full Load: 96 percent.
   H. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   I. Starting Torque: 100 percent of rated torque or as indicated.
   J. Speed Regulation: Plus or minus 1 percent with no motor derating.

2.4 DESIGN
   A. Pulse Width Modulated (PWM) Variable Frequency Drives:
      1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section.
2. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz. The PWM carrier frequency shall be adjustable from 5000 Hz to 15000 Hz. If derating of the inverter is necessary to run at 8kHz, then the unit’s derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.

3. All controllers supplied with semi-conductors capable of switching at less than 8,000 Hertz shall be supplied with a motor acoustic noise reduction filter.

4. Pulse width modulated (PWM) drives shall be supplied with drive input line reactors with a minimum impedance of 3%. Reactors shall be installed to filter entire drive input circuit.

5. Pulse width modulated (PWM) drives shall be supplied with drive input harmonic filter to reduce the total harmonic distortion to less than the IEEE519-1992 limits at the utility service entrance.

6. Drives that are located beyond the manufacturer’s recommended maximum distance from the motor shall be provided with dV/dt (long lead) filters.

B. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.

C. Drive shall restart after power loss and under-voltage fault. The minimum number of restart attempts required shall be three, field adjustable.

D. The drive shall allow unlimited switching of the output without damage to the drive or motor.

2.5 PRODUCT FEATURES

A. Display: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current.

B. Protection:

1. Input transient protection by means of surge suppressors.

2. Snubber networks to protect against malfunctions due to system transients,

3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.

4. Motor thermal overload relay(s) adjustable and capable of NEMA 250 and sized per motor nameplate data.

5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.

6. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.


9. Short-circuit protection (fuses or circuit breaker).
10. Motor overtemperature fault.

C. Acceleration Rate Adjustment: 0.5 - 30 seconds.
D. Deceleration Rate Adjustment: 1 - 30 seconds.
E. Minimum Adjustment Range for the Lower Output Frequency shall be: 0 to 40 Hertz.
F. Minimum Adjustment Range for the Upper Output Frequency Range shall be: 40 to 90 Hertz.
G. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.
H. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.
I. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
J. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.
K. Provide adjustable skip frequencies on the drive output (minimum of three ranges).
L. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
M. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.

R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

S. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 5/10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
   
a. 0 to 5-V or 0 to 10-V dc.
b. 0-20 or 4-20 mA.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.
e. RS485.
f. Keypad display for local hand operation.

3. Output Signal Interface:

   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:

   a. Motor running.
b. Set-point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

T. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 09 00. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.
U. Control:

1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door.

2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.

3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.

4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.

5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass.

6. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

2.6 OPERATING REQUIREMENTS

A. Rated Input Voltage for motors rated below 40 HP: 200 volts, three phase, 60 Hertz, with a voltage tolerance of +/- 10% and a frequency tolerance of +/- 2 Hz.

B. Rated Output: Output frequency shall vary between 0.1 Hz and 400 Hz. Frequency resolution shall be 0.01 Hz digital and 0.03 Hz analog with an accuracy of +/-0.2% of maximum frequency at 25 degrees Celsius. Maximum voltage frequency shall be adjustable from 25 Hz to 400 Hz. Voltage boost shall be adjustable from 0% to 30% with starting frequency adjustable from 0 Hz to 10 Hz. The output current shall be 100% continuous and 110% for 60 seconds, based on NEC table 430-150 (Full-Load Current, Three-Phase Alternating Current Motors) for 200 volts or 460 volts.

C. The controller shall contain three critical frequency jump points with individual bandwidth. Upper and lower frequency limits shall be capable of being varied.

D. The PWM carrier frequency shall be adjustable from 5000 Hz to 15000 Hz.

E. The drive shall contain two separate acceleration/deceleration times (0.1 to 6000 seconds) with a choice of linear, S, or C curves. The drive shall have a standard dynamic electric braking for motors rated 30 HP or below. The drive shall restart into a rotating motor by sensing the coasting motor speed and matching that frequency. The drive shall have adjustable soft stall (10%-150%) and adjustable electronic overload protection (10%-100%).

F. The drive shall have external fault input, be capable of re-setting faults remotely and locally.
G. Input Signal:
   1. 0 to 10 v DC
   2. 0 to 5 v DC
   3. 4 to 20 mA DC

H. Manual bypass is not required on VFD unless indicated on bid documents.

2.7 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. All VFD supplied for fans shall have dynamic or DC injection braking capability to provide a means of rapid deceleration of the AC motor in not more than one minute. Adjust controls to stop the motor within 30 seconds.

C. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds.


E. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

F. Control Relays: Auxiliary and adjustable time-delay relays.

G. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   7. Motor output voltage (V).

H. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

I. Fabrication:
   1. Enclosure: NEMA 250, Type 1.
   2. Finish: Manufacturer's standard enamel.
J. Forced Ventilation:
   1. Inlet filter, outlet filter.
   2. Blower fan sized to maintain VFD at rated operating temperatures for ambient conditions of enclosure location.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The VFD manufacturer shall provide certification that heat test has been completed.

B. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.

3.2 INSTALLATION

A. Install variable frequency drive equipment in accordance with NEMA ICS 7.1, manufacturer's instructions, and per drawings.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.

D. Provide engraved phenolic nameplates under the provisions of Section 26 05 53.

E. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.

F. The service disconnect switch must be installed on the line side of the VFD. The disconnect must be in a separate enclosure from the VFD. If conditions do not allow this disconnect to be located near the motor within NEC requirements, then a second remote disconnect may be required at the motor. Consult the project manager or University Engineer if this condition arises. All remote disconnects must be provided with auxiliary contacts hardwired to VFD safety circuit to shut down VFD when disconnect is opened. This may affect warranty on the drive so every attempt should be taken to install it per these design guidelines.

G. Connections: All conduit connections to the VFD shall be by flexible conduit.

H. Input, output, and control wiring shall each be run in separate conduits.

I. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.
3.3 STARTUP AND COMMISSIONING

A. Prior to initial energization, provide the service of the manufacturer’s field representative to prepare and start controllers.

B. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.

C. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.

D. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.


F. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

END OF SECTION
SECTION 28 31 00
FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Fire alarm and detection systems

1.2 RELATED WORK
A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 QUALITY ASSURANCE
A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years’ experience.
B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with five years’ experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.
C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person’s name and certification number shall appear on the start-up and testing reports.

1.4 REFERENCES
A. NFPA 70 - National Electrical Code
B. NFPA 72 - National Fire Alarm and Signaling Code
D. UL 2017 – General Purpose Signaling Devices and Systems

1.5 SUBMITTALS
A. Submit shop drawings and product data under provisions of Division 1 and as noted below.
   1. Failure to comply with all the following and all the provisions in Division 1 will result in the shop drawing submittal being rejected without review.
   2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.
B. Provide product catalog data sheets as shop drawings.
   1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings but required for the operation of the system.
   2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to
be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.

3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.

C. Submit CAD floor plans as shop drawings:
   1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer’s wiring requirements shall be shown.
   2. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.

D. About all fire alarm circuits, provide the following: manufacturer’s wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.

E. Provide installation and maintenance manuals under provisions of Section 26 05 00.

F. Submit manufacturer’s certificate that system meets or exceeds specified requirements.

G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.

H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.

I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a Professional Engineer’s stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

1.6 REGULATORY REQUIREMENTS

A. System: UL or FM Global listed.

B. Conform to requirements of NFPA 101.

C. Conform to requirements of Americans with Disabilities Act (ADA).

D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

1.7 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
B. Extending the existing NOTIFIER NFS2-3030 fire alarm system: The existing control panel shall remain and shall be operational throughout construction. The system shall only be disabled to make new connections and to modify the programming. A fire watch shall be provided for all areas affected during outages. All system outages must be scheduled with the Owner at least one week prior. Individual devices may be disabled as needed based on construction activities to reduce the potential for false alarms, but all devices must be operational when the Contractor is not physically on site. New initiating devices may be connected to the existing signaling line circuits where capacity is available. Provide additional signaling line circuits as needed based on existing and new device quantity, including replacement of existing panel components. Provide new notification circuits to serve the new devices, including all necessary power supplies, amplifiers, batteries, and 120-volt input circuits. All new devices shall be programmed to provide the same sequence of operation as the existing devices of the same type, unless noted otherwise.

C. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown but shall be submitted on the shop drawings.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Division 1.

B. Include location of end-of-line devices.

C. Provide a CAD drawing of each area of the building (minimum scale of 1/16” = 1’-0”) showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Division 1.

B. Include operating instructions, and maintenance and repair procedures.

C. Include results of testing of all devices and functions.

D. Include manufacturer’s representative’s letter stating that system is operational.

E. Include the CAD floor plan drawings.

F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

1.10 WARRANTY

A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.

B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Notifier by Honeywell

2.2 SIGNALING LINE CIRCUIT DEVICES

A. [FA-120]: Smoke Detectors:

1. Analog Photocell Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.

2. Each smoke detector shall connect directly to an SLC loop.

3. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.

4. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.

5. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.

6. A test means shall be provided to simulate an alarm condition.

7. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

8. Audible sounder detector base for sleeping room applications:

   a. The audible base shall sound an alarm in the local room in UL2017 operation and UL484 for general evacuation. The unit shall be programmable by the main control panel for the duration of operation.

   b. The audible sounder base shall sound Temporal 3 (fire) or Temporal 4 (CO alarm) and be at 75 dB at 10 feet.

9. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Recall, S=Sleeping/Patient Room, D=HVAC Control, A=Atrium, SW=Stairwell, CR=Computer Room, SD=Smoke Dampers, DH=Door Hold Release, FD= Fire Door Release, MP=Medical Procedure Room.

B. [FA-122]: Duct Smoke Detectors:

1. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.

2. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, the Contractor...
shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer’s recommendations.

3. Provide a remote alarm LED indicator device (FA-240/241) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

C. **[FA-160]: Monitor Modules:**

1. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.

2. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.

3. The module shall supply the required power to operate the monitored device(s).

4. The module shall provide address setting means using rotary decimal or DIP switches.

D. **[FA-161]: Addressable Relays:**

1. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional slave relay(s), as required, rated for the electrical load being controlled (contractor to match voltage, amps, etc.).

2. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.

3. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.

4. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

2.3 **NOTIFICATION APPLIANCE DEVICES**

A. **Device Color:**

1. Wall Mounted: Red housing with white lettering or pictogram.

B. **Visual Alarm Devices:**

1. **[FA-200]:** Wall mounted.

2. **[FA-201]:** Ceiling mounted.
3. High intensity (candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
   a. Candela Ratings: V1=15, V3=30, V7=75, VH=110, VS=177.
4. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

2.4 WIRING
   A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer’s recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with NFPA 70, Article 760 for power-limited fire alarm signal service.
   B. Approved manufacturers of fire alarm cable:
      1. Comtran Corp.
      2. Helix/HiTemp Cables, Inc.
      3. Rockbestos-Suprenant Cable Corp.
      4. West Penn Wire/CDT.
      5. Radix.

PART 3 - EXECUTION

3.1 SEQUENCES OF FIRE ALARM OPERATION
   A. AHU and Mechanical Fan Shutdown Sequence:
      1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers and mechanical fans. Coordinate other requirements with HVAC installer.
      2. The fire alarm system shall directly shut down the AHU or mechanical fan through the local HVAC control device (i.e., variable frequency drive or motor starter).
      3. Where a facility has more than one AHU or mechanical fan, each shall be shutdown individually based on input from initiation devices in the area served by the unit or designated for each air distribution system.
   B. Elevator Shutdown Sequence:
      1. Elevator shutdown shall meet the requirements of ASME/ANSI A17.1.
      2. All elevators that share the same hoistway, machine room, or lobby shall be shut down simultaneously. Elevators served by different machine rooms, hoistways, and lobbies shall continue to operate.
      3. The fire alarm system shall utilize an addressable relay to energize the shunt trip of the main elevator breaker, disconnecting power to the elevator.
4. The fire alarm system shall utilize an addressable relay to de-energize the relay on the elevator power module, disconnecting power to the elevator.

3.2 INSTALLATION

A. Install system in accordance with manufacturer's instructions and referenced codes.

B. Devices:

1. General:
   a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
   b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
   c. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall notify the Architect/Engineer to coordinate a different acceptable location.

2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.

3. Analog Smoke and Heat Detectors:
   a. In elevator shafts and elevator equipment rooms, provide a heat detector for elevator shutdown within 2’ of every sprinkler head. Coordinate with fire protection contractor.

4. Duct-type Analog Smoke Detectors:
   a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
   b. All detectors shall be accessible.
   c. Duct-type detectors shall be installed according to the manufacturer's instructions.
5. Addressable Relays and Monitor Modules:
   a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
   b. All modules shall be mounted in or on a junction box in an accessible location.
   c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.

6. Notification Appliance Devices:
   a. Devices shall be located where shown on the drawings.
   b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.

C. Wiring:
   1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer’s recommendations and pursuant to National Fire Codes.
   2. Wiring shall be installed in conduit.
   3. All junction boxes with SLC and NAC circuits shall be identified on cover.
   4. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with “E-Z Markers” or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

D. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows or using colored tape at each conductor termination and in each junction box.
   1. Power branch circuit conductors: In accordance with Section 26 05 53.
   2. Signaling line circuit: Overall red jacket with black and red conductors.
   3. DC power supply circuit: Overall red jacket with violet and brown conductors.
   4. Notification appliance circuit: Overall red jacket with blue and white conductors.

E. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer’s product data and shop drawings.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed.
B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.

3.4 MANUFACTURER’S FIELD SERVICES

A. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

END OF SECTION
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