PROJECT MANUAL FOR:
UNIVERSITY OF MISSOURI TEACHING HOSPITAL – NORMAL POWER UPGRADE

PROJECT NUMBER: CP191241

AT
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

Burns & McDonnell Engineering Company, Inc.
Reid DeBaun
9400 Ward Parkway
Kansas City, MO 64114
816-333-9400

DATE: November 18, 2019

I hereby certify that these Drawings A-001, A-002, A-101 and Specifications Division 04, Division 07, Division 08, and Division 09 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: ________________________

STATE OF MISSOURI
ARCHITECT
MARK ANDREW OQUIST
NUMBER A-201201409
11-11-19
I hereby certify that these Drawings M-001, M-101, M-501, M-502, M-701, M-702, P-001, P-101, F-001, F-101 and Specifications Division 22 and Division 23, excluding section 230940 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: [Signature]

I hereby certify that these Drawings E-001, E-101, E-102, E-103, E-104, E-105, E-106, E-107, E-108, E-501, E-502, E-503, E-601, E-701 and Specifications Division 26 and Division 33, excluding sections 260800, 260813, and 260816 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: [Signature]
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26 11 16 SECONDARY UNIT SUBSTATIONS
26 23 00 LOW-VOLTAGE SWITCHGEAR
26 27 26 WIRING DEVICES
26 28 13 FUSES
26 28 16 CIRCUIT AND MOTOR DISCONNECT SWITCHES
26 51 00 LIGHTING

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DIVISION 28 ELECTRONIC SAFETY AND SECURITY (NOT USED)

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DIVISION 32 EXTERIOR IMPROVEMENTS (NOT USED)

DIVISION 33 UTILITIES
33 71 49 MEDIUM VOLTAGE CABLES
33 71 73.33 ELECTRIC METERS

END OF SECTION
ADVERTISEMENT FOR BIDS

Sealed bids for:

UNIVERSITY OF MISSOURI TEACHING HOSPITAL –
NORMAL POWER UPGRADE
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
PROJECT NUMBER: CP191241 CONSTRUCTION ESTIMATE $2,908,000 - $3,231,000

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., December 12, 2019 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 Reid DeBaun with Burns & McDonnell Engineering Company, Inc. at (816) 333-9400 or rdebaun@burnsmcd.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 p.m., C.T., December 3, 2019 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 mucfmprebidinspectionguides@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: November 18, 2019

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

   c/o Associate Vice Chancellor – Facilities
   Room L100, General Services Building
   University of Missouri
   Columbia, MO 65211

1. Bidder, in compliance with invitation for bids for construction work in accordance with Drawings and Specifications prepared by Burns & McDonnell Engineering, Inc., entitled "UNIVERSITY OF MISSOURI TEACHING HOSPITAL – NORMAL POWER UPGRADES", project number CP191241, dated November 18, 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 replace existing substations MLA, MLB, MPA, MPB, X-RAY A, and X-RAY B with new double-ended service substations LNA/LNB and HNA/HNB, and to replace the existing mechanical ventilation system serving the electrical spaces with a new cooling system; all as indicated on the Drawings and described in these Specifications for sum of:

DOLLARS ($ ____________________________).

b. Additive Alternate Bids: (Not Used)

c. Unit Prices: (Not Used)
d. Allowance:

Bidder shall include in the base bid sum an allowance of $20,000 for firestopping existing penetrations in ground floor fire walls. 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 sixty-five (365) 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 – (Not Used)

d. Refer to Special Scheduling Requirements in Special Conditions for specific scheduling of the following activities:
   1. Special work times
   2. Exhaust System work
   3. Incidental Floor Work (work in other occupied spaces for utility tie-ins)
   4. Crane work
   5. HVAC Testing and Balancing
   6. Utility Shut-downs, Outages and Tie-ins
   7. 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>
<thead>
<tr>
<th>Work to be performed</th>
<th>Subcontractor Name</th>
<th>City, State</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM/UL Certified Fire Stopping Contractor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.A - 2
6. SUPPLIER DIVERSITY GOALS

a. The Contractor shall have as a goal, subcontracting with Minority Business Enterprise (MBE) of ten percent (10%), with Service Disabled Veteran Owned Business (SDVE) of three percent (3%); and with Women Business Enterprise (WBE), Disadvantage Business Enterprise (DBE), and/or Veteran Owned Business of ten percent (10%) 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 Supplier Diversity participation level:

   MBE PERCENTAGE PARTICIPATION: _____________________ percent (_______ %)
   SDVE PERCENTAGE PARTICIPATION: ____________ percent (_____ %)
   WBE, DBE, 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>
</tr>
</thead>
</table>

_________________________________________________________________________

_________________________________________________________________________

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>
<th>Phone Number</th>
<th>Architect</th>
<th>Amount of your Contract</th>
<th>Percent Completed</th>
</tr>
</thead>
</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.

I. Project:
   
   ________________________________________________________________

II. Name of General Contractor:____________________________________

III. Name of Diverse Firm:________________________________________

   Address:_____________________________________________________

   Phone No.:_________________________  Fax No.:_____________________

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

IV. Describe the subcontract work to be performed.  (List Base Bid work and any Alternate work separately):

   Base Bid:_____________________________________________________

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

V. Dollar amount of contract to be subcontracted to the Diverse firm:

   Base Bid:_____________________________________________________

   Alternate(s), (Identify separately):_______________________________

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

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?

   Yes _____  No _____
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______________________________________________
"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  )
) ss.
County of  )

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: oeao.mo.gov/sites/default/files/sdvelisting.pdf
W: oeao.mo.gov/
Minority Newspapers

Dos Mundos Bilingual Newspaper
902 A 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
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:

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   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

1. Contract Documents
   1.1 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.

2. Bidder Obligations
   2.1 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.

   2.2 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.

   2.3 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.

   2.4 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.

3. Interpretation of Documents
   3.1 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.

   3.2 Requests for such interpretations shall be delivered to the Architect at least one (1) week prior to time for receipt of bids.

3.3 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.

4. Bids
   4.1 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.

   4.2 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.

   4.3 Bids shall be presented in sealed envelopes which shall be plainly marked "Bids for (indicate name of project from cover sheet)", 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.

   4.4 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 & State taxes shall not be included as defined within Article 3.16 of the General Conditions for Construction Contract included in the contract documents.

   4.5 Bids shall be submitted on a single bid form, furnished by the Owner or Architect. Do not remove the bid form from the specifications.

   4.6 No bidder shall stipulate in their bid any conditions not contained in the bid form.
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 bid 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 Statue 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 meet 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, and 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
actually performing, managing and supervising the work involved. A bidder that is a certified diverse firm may count as 100% of the contract towards the Supplier Diversity goal. For projects with separate MBE, SDVE, and WBE/Veteran /DBE goals, a MBE firm bidding as the prime bidder is expected to obtain the required SDVE, and WBE/Veteran/ DBE participation; a WBE or Veteran or DBE firm bidding as the prime bidder is expected to obtain the required MBE and SDVE participation and a SDVE firm bidding as the prime bidder is expected to obtain the required MBE, and WBE/Veteran/ DBE participation.

15.4.3 When a MBE, WBE, Veteran Business Enterprise, DBE, or SDVE performs work as a participant in a joint venture, only the portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the MBE, WBE, Veteran Business Enterprise, DBE, or SDVE performs with its own forces shall count toward the MBE, WBE, Veteran Business Enterprise, DBE, or SDVE individual contract percentages.

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 firm assumes the actual and contractual responsibility for the provision of the materials and supplies.

15.4.4.1 The bidder may count its entire expenditure to a diverse manufacturer. A manufacturer shall be defined as an individual or firm that produces goods from raw materials or substantially alters them before resale.

15.4.4.2 The bidder may count its entire expenditure to diverse suppliers that are not manufacturers provided the diverse supplier performs a commercially useful function as defined above in the supply process.

15.4.4.3 The bidder may count 25% of its entire expenditures to diverse firms that do not meet the definition of a subcontractor, a manufacturer, nor a supplier. Such diverse firms may arrange for, expedite, or procure portions of the work but are not actively engaged in the business of performing, manufacturing, or supplying that work.

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. Bidder’s 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.
University of Missouri

General Conditions

of the

Contract

for

Construction

August 2018 Edition
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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, incidental 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 be 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 shall submit 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 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 conditions bearing upon transportation, disposal, handling, and storage of materials;
.2 the availability of labor, materials, equipment, water, electrical power, utilities and roads;
.3 uncertainties of weather, river stages, flooding and similar characteristics of the site;
.4 conditions bearing upon security and protection of material, equipment, and Work in progress;
.5 the form and nature of the Work site, including the surface and sub-surface conditions;
.6 the extent and nature of Work and materials necessary for the execution of the Work and the remedying of any defects therein; and
.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.
.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
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 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
clean the Work site and surrounding areas as requested by the Architect and the Owner's Representative, including mowing of grass greater than 6 inches high. The Contractor shall be responsible for the cost of clean up and removal of debris from premises. The building and premises shall be kept clean, safe, in a workmanlike manner, and in compliance with OSHA standards at all times. At completion of the Work, the Contractor shall remove from and about the Work site tools, construction equipment, machinery, fencing, and surplus materials. Further, at the completion of the work, all dirt, stains, and smearages shall be removed from every part of the building, all glass in doors and windows shall be washed, and entire Work shall be left broom clean in a finished state ready for occupancy. The Contractor shall advise his Subcontractors of any tier of this provision, and the Contractor shall be fully responsible for leaving the premises in a finished state ready for use to the satisfaction of the Owner's Representative. If the Contractor fails to comply with the provisions of this paragraph, the Owner may do so and the cost thereof shall be charged to the Contractor.

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 claim.
3.11.2 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.

3.11.3 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 submission 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.
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...
for the Work shall present such certificate to all material suppliers as authorization to purchase, on behalf of the Owner, all tangible personal property and materials to be incorporated into or consumed in the Work and no other on a tax-exempt basis. Such suppliers shall provide to the purchasing party invoices bearing the name of the exempt entity and the project identification number. Nothing in this section shall be deemed to exempt from any sales or similar tax the purchase of any construction machinery, equipment or tools used in construction, repairing or remodeling facilities for the Owner. All invoices for all personal property and materials purchased under a Project Tax Exemption Certificate shall be retained by the Contractor for a period of five years and shall be subject to audit by the Director of Revenue.

3.16.3 Any excess resalable tangible personal property or materials which were purchased for the project under this Project Tax Exemption Certificate but which were not incorporated into or consumed in the Work shall either be returned to the supplier for credit or the appropriate sales or use tax on such excess property or materials shall be reported on a return and paid by such purchasing party not later than the due date of the purchasing party’s Missouri sales or use tax return following the month in which it was determined that the materials were not used in the Work.

3.16.4 If it is determined that sales tax is owed by the Contractor on property and materials due to the failure of the Owner to revise the certificate expiration date to cover the applicable date of purchase, Owner shall be liable for the tax owed.

3.16.5 The Owner shall not be responsible for any tax liability due to Contractor’s neglect to make timely orders, payments, etc. or Contractor’s misuse of the Project Tax Exemption Certificate. Contractor represents that the Project Tax Exemption Certificate shall be used in accordance with RSMo § 144.062 and the terms of the Project Tax Exemption Certificate. Contractor shall indemnify the Owner for any loss or expense, including but not limited to, reasonable attorneys’ fees, arising out of Contractor’s use of the Project Tax Exemption Certificate.

3.17 Contractor’s Construction Schedules

3.17.1 The Contractor, within fifteen (15) days after the issuance of the Notice to Proceed, shall prepare and submit for the Owner’s and Architect’s information Contractor’s construction schedule for the Work and shall set forth interim dates for completion of various components of the Work and Work Milestone Dates as defined herein. The schedule shall not exceed time limits current under the Contract Documents, shall be revised on a monthly basis or as requested by the Owner’s Representative as required by 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
Claims must be made by written notice. Contractor shall have the responsibility to substantiate Claims.

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 on 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 investigations 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 additional time in the Contract Time, written notice as provided herein shall be given in connection with 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. 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...
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, Christmas Day, unless that specific day was approved in writing for work by the Owner’s Representative.

.1 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.

.2 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.
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 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
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.

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 the 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 Contract Sum 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.
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 notice 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

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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
portions 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

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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

.3 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 for Construction 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 showing 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, lightening, 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) RSMo 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
records. The Owner may, at any time, request copies of, and/or inspect all of the Contractor's payroll records for the Work to verify compliance. The Contractor shall furnish the Owner copies of payroll records within 10 days of the Owner’s written request. The Contractor shall provide copies of workers I-9 forms within 24 hours of written notice. (If applicable, and required by Owner, the Contractor will demonstrate that the Contractor is enrolled and participating in a federal work authorization program with respect to the employees working in connection with this project.) Such payroll records shall be maintained in accordance with Article 13.7.1 and shall be available for inspection for two (2) years after final completion of the Work. The contractor further agrees, in the event the records are not presented as requested, he will abide by any decision made by the Owner regarding underpayment of wages to workers and amounts owed them as well as liquidated damages for underpayment of wages. Falsification of the certified payroll records may result in the debarment of the contractor or subcontractor from future work with the University.

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 of 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 Architect's 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

a. "Drawings"

Drawings referred to in and accompanying Project Manual consist of Drawings prepared by and bearing name of below defined Architect, bearing November 18, 2019 – “University of Missouri Teaching Hospital – Normal Power Upgrade”.

b. Architect & Engineer
Burns & McDonnell Engineering, Inc.
9400 Ward Parkway


2. SPECIAL SCHEDULING REQUIREMENTS

a. Special scheduling requirements supplemental to the bid form

(1) Normal working hours are defined as weekdays between the hours of 6:00 am and 5:00 pm.

(2) Night hours are defined as Monday through Thursday, after 5:00 p.m. and before 6:00 a.m. Noisy work must stop between the hours of 9:00 p.m. and 6:00 a.m.

(3) Weekend hours are defined as after 5:00 p.m. on Friday until 6:00 a.m. Monday.

(4) Excessive Noisy Work hours - All interior concrete demolition work shall occur between 6:00 a.m. and 10:00 a.m. Such work shall be coordinated and approved at least 24 hours in advance with Owner’s Representative.

(5) Utility outages must be coordinated with Owners Representative with a minimum of 14 days notice. Some feeders may be acceptable to be combined into a single outage while other feeders may require individual outages. Outages may only occur between the hours of 10:00 p.m. Thursday and 4:00 a.m. Friday unless approved by Owners Representative.

b. 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. Coordination location of crane with Owner’s personnel.

c. HVAC Testing and Balancing Provision – Allow five (5) working days for Owner to perform testing and balancing of HVAC system prior to occupancy.
d. Utility Shut-Downs, Outages, and Tie-ins – Contractor shall submit a Utility Outage Request Form including a written plan outlining the required shut-downs, outages, and tie-ins fourteen (14) calendar days prior to starting the work.

a. Contractor shall implement a “Fire Watch” during, at a minimum, the following conditions:
   i. Fire Alarm System out of service for more than four (4) hours in a 24-hour period
   ii. Fire Sprinkler System out of service for more than ten (10) hours in a 24-hour period
   iii. Fire Pump out of service for more than ten (10) hours in a 24-hour period

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.

A log shall be maintained identifying personnel performing fire watch duties and time period(s) assigned to the individual(s).

e. Refuse/Trash Removal and Material Delivery:
   a. Contractor can use the loading dock elevator between the hours of 6:00 p.m. and 10:00 p.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.
   b. Contractor can use the areaway / exterior stairwell located south of the ED entrance for delivery and removal of large and heavy items between the hours of 4:00 a.m. and 10:00 a.m. with approval from Owners Representative. Use of crane or boom truck requires a minimum of 72 hours notice.

f. Payments for switchgear will not be made prior to July 1, 2020. Contractor to plan and coordinate accordingly.

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 replacement of existing substations MLA, MLB, MPA, MPB, X-RAY A, and X-RAY B with new double-ended service substations LNA/LNB and HNA/HNB, and the replacement of the existing
mechanical ventilation system serving the electrical spaces with a new cooling system.

(2) Demolition shall consist of the removal of existing substations MLA, MLB, MPA, MPB, X-RAY A, and X-RAY B, removal of the existing ventilation system serving the electrical spaces, and removal of the dividing wall separating rooms GS-01 and GS-02.

(3) Architectural work shall consist of the removal of the dividing wall separating rooms GS-01 and GS-02, removal of doors entering GS-01 and GS-02, filling in holes in the walls created by the removal of doors, and installing new doors to serve GS-01/GS-02. Additionally, demolition and patching and repairing any wall penetrations required for new work to match existing conditions.

(4) Mechanical work shall consist of the removal of the existing mechanical ventilation system serving the electrical spaces and replacement with a new cooling system to cool the electrical spaces.

(5) Electrical work shall consist of the replacement of existing substations MLA, MLB, MPA, MPB, X-RAY A, and X-RAY B with new double-ended service substations.

4. LOCATION

Work shall be performed under this Contract on campus of the University of Missouri - Columbia, at the University of Missouri Teaching Hospital.

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. 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 in a three-ring binder and one (1) pdf copy 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

Before beginning Demolition Work or service outages, the Contractor shall provide, at minimum, fourteen (14) days 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.

b. Parking:

(1) No parking permits will be issued for this project.

(2) Parking of personal vehicles within project access/lay down/staging areas is prohibited. Violation of this requirement may result in ticketing and/or towing at the vehicle owner’s expense and suspension of progress payments.

(3) Parking or driving on sidewalks, landscaped areas, within fire and service lanes or generally in areas not designated for vehicular traffic is prohibited except as allowed in the contract documents. Violation of this requirement may result in ticketing and/or towing at the vehicle owner’s expense and suspension of progress payments.

(4) Free parking for contractor employees is available in the Ashland Road Contractor lot on an as available basis. This space is for use by contractor employees for parking their personal vehicles only and is not to be used for staging or storage.

(5) Vendor Permits may be purchased by contractor management personnel on an as available basis by contacting the MU Parking and Transportation office. These permits will allow contractor management personnel to park in various University lots while conducting business on University construction projects.

(6) Temporary University parking permits may be purchased by contractor employees for use with their personal vehicles on an as available basis by contacting the MU Parking and Transportation office.

(7) Conley Avenue between Missouri Avenue and University Avenue and Hitt Street between University Avenue and the Memorial Union are designated for pedestrian use only during the work week between the hours of 8:15 AM and 3:45 PM. Unless otherwise indicated in the contract documents, this area is strictly off limits to vehicular traffic without authorization from the Owner’s Representative.

(8) Parking at University Hospital: Limited contractor parking is available near the corner at Virginia Avenue and Hospital Drive as directed by Owner’s Representative.

c. Storage of materials: The Contractor shall store all materials within project limits. The Contractor shall confine apparatus, materials, and operation of workers to location established by the Owner's Representative. The Contractor shall not unreasonably encumber premises with materials. In addition, storage trailer locations may be available within 1-1/2 miles of project site as directed by the Owner’s Representative. Storage trailer locations shall be subject to approval by
the Owner's Representative and are available to the Contractor without cost.

d. 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.

e. 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.

f. 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.

g. 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.

h. 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.

i. 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 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.

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

k. 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. The 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.

b. Construction Project Fencing:

   (1) Fencing will not be required as a part of work.

c. Preserving and Protecting Existing Vegetation: (Not Used)

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. Use of materials, products or equipment other than those named and described in the Contract Documents are substitutions and/or equal. Substitutions and/or equals of any item described in the Contract Documents will be allowed only prior to the receipt of bids provided that a 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. To be considered, bidder’s proposal shall include a complete description of the proposed substitution and/or equal and a comparison of significant qualities of the proposed substitution and/or equal with those specified including drawings, performance and test data, and other information necessary for an evaluation. The Architect's decision on the approval or disapproval of a proposed substitution and/or equal shall be final.

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:

<table>
<thead>
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<th>Specification Section</th>
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<tbody>
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<td>08 7100</td>
</tr>
<tr>
<td>Fire Alarm System</td>
<td>28 3100</td>
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</table>
11. CODES AND STANDARDS

The Contractor shall comply with applicable codes and standards as listed in General Conditions. All applicable codes and standards referenced in the Construction Documents shall also apply.

12. PERMITS

Permits and inspection for work on UM property are required.

a. The owner's Representative shall secure University Authority Having Jurisdiction building permits required for the project and shall provide a list of required inspection to the Contractor.
   i. The Contractor shall coordinate and provide reasonable scheduling and access to the Work for the Owner’s Inspection.
   ii. Re-inspection of work as a result of either failed inspection or work not ready as scheduled may be at the Contractor’s expense.

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

c. 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.

d. 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/.

13. SPECIALTIES (Not Used)

14. PRE-BID INSPECTION

All pre-bid inspections of work areas shall be scheduled with pre-bid inspection guide, telephone: (573) 882-2228

15. ROOF WARRANTY REQUIREMENT (Not Used)

16. 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.

17. MODIFICATION TO INFORMATION FOR BIDDERS: BIDDERS STATEMENT OF QUALIFICATIONS (Not Used)

18. MODIFICATIONS TO GENERAL CONDITIONS (Not Used)

19. PROJECT SCHEDULING

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.

Option 3: 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.

20. 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.

21. PROJECT PARTNERING (Not Used)

22. VALUE ENGINEERING (Not Used)

23. BUILDING SYSTEM COMMISSIONING

a. Contractor shall provide all personnel and equipment required to complete the commissioning activities referenced in the Commissioning Plan. The requirements of the commissioning 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 to act as the contractor’s Quality Control Coordinator (QCC). The Contractor’s Project Manager or Superintendent may also function as the QCC. The QCC is responsible for planning, scheduling, coordinating, conducting, documenting and verifying all activities required by the project plans and specifications and Quality Commissioning Plan/Log and coordination with the Owner’s Commissioning Agent ensuring all building systems are complete, operable and ready for use by the Owner. Systems include (but are not limited to); building ventilation systems, chilled/hot water generation systems, hydronic distribution systems, power distributions systems and fire detection and alarm systems, as applicable.

c. The QCC is responsible for planning, coordinating, and scheduling commissioning meetings, testing and inspections of materials and processes for the project. The QCC will document meetings and distribute meeting minutes of these meetings in a timely manner.

d. QCC will review all submittals for coordination between trades, and equipment requirements.

e. QCC will verify all materials received on site for installation on the project are approved submitted item and document same.

f. The QCC will plan, coordinate, schedule meetings and provide and distribute meeting minutes for the following as indicated by the MU-CM Pre-Installation Log or Spreadsheet:

i. Each definable feature of work requires a Pre-Installation Meeting. Definable feature of work will be at the discretion of the MU CPM, but will include at a minimum; mobilization, utilities, steel, metal framing, glass and glazing, electrical, mechanical, plumbing, fire protection, ceiling systems, drywall, wall finishes, flooring, and roofing. The QCC will work with MU-CM in the development of the Pre-Installation Log.

ii. Pre-Installation Review Meeting Agenda, (at a minimum) will be: Review specifications and drawings and mock ups, ensure approved submittals are in place, RFI’s have been answered, change orders addressed, materials are in place to begin work, equipment to be used has been tested/inspected/in proper working order, all applicable permits have been procured, to include above ceiling permits, hot work permits. Infection control and life safety processes are approved and in place. Initial Safety Review has been conducted, documented. The area to be worked in (if outside the specific project footprint) has been visually verified by the project team and coordination with the Owner’s Rep and other

iii. MUHC entities has taken place in preparation for the start of work activity. Plans are in place and communicated for outages of any kind related to the start of work activity.
iv. Installation In-Progress Review: QCC will verify, (and document and distribute) after set time of progress that; work is in compliance, the level of workmanship is acceptable, safety reviews are verified and conducted, and required inspections and testing are being conducted and documented.

24. 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. 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.

25. COST BREAKOUT FOR OWNER’S ACCOUNTING PURPOSES (Not Used)

26. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS

a. The Contractor shall be represented by a competent Project Manager and Superintendent. The Project Manager does not need to be on site full time. The competent Superintendent will be required to be at the site fulltime. He will have 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. The Superintendent may also serve as the QCC.

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 records.
documents and revisions.

d. The Contractor shall provide his on-site Superintendent with a handheld cellular telephone.

27. SAFETY PRECAUTIONS AND PROGRAMS

a. The Bidder’s Statement of Qualifications includes a requirement that the Bidder provide its Worker’s Compensation Experience Modification Rates (EMR) and Incidence Rates for the three recent years. The Bidder shall also include the EMR and Incidence Rates of listed major subcontractors on the Bid for Lump Sum Contract. If the EMR exceeds 1 or the Incidence Rate exceeds 13, the Contractor or major subcontractor shall take additional safety measures including, but not limited to, developing a site specific safety plan and assigning a Safety Manager to the Project to perform inspections on a schedule as determined acceptable by the Owner with written reports to be submitted to the Owner. The Owner reserves the right to reject a Bidder or major subcontractor whose rates exceed these stated rates.

b. The contractor shall provide Emergency Contact Information for the Contractor’s on-site staff and home office management as well as contact information for all major subcontractor personnel. This information shall contain business and personal phone numbers for each individual for contact during or after hours in case of an emergency. This information shall be submitted within 15 days of the Notice to Proceed.

28. CONSTRUCTION WASTE MANAGEMENT

Contractor shall track and report all efforts related to recycling, reusing, and/or re-selling of all salvaged material from the project (including clean fill material). Report total weight of all demolition waste and clean fill material diverted from a landfill. Report all material types and weights, where material was diverted, type of diversion, documentation of this diversion, and applicable dates. Total weights and percentages of total demolition material shall also be reported.

This information shall be in tabular form utilizing the Construction Waste Management Plan. (This information shall be updated monthly with final submission prior to substantial completion).

29. WARRANTY WALKTHROUGH

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.

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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” (CRMICRM) 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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<th>Better</th>
<th>Minimum</th>
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**Date:**

**Time:**

**Negative Air Unit No.:**

**Inspected By:**

**Actions Taken (Filter Change, Pre Filter, HEPA, Other):**

### Table

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<th>Time</th>
<th>Negative Air Yes</th>
<th>Negative Air No</th>
<th>Unit No.</th>
<th>Inspected By</th>
<th>Actions Taken (Filter Change, Pre Filter, HEPA, Other)</th>
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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 shut downs 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.

<table>
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<tr>
<th>Category</th>
<th>Required Notice</th>
<th>Form</th>
<th>Permit Approval</th>
<th>Job Site Posting</th>
<th>Contractor Safety File</th>
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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 Through 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.
Option #3 – 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 ensure 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.

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2. SCHEDULING PROCESS
   a) The intent of this section is to ensure 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 fragnets 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 Contractor's 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.
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**SDSL - 2**
## SHOP DRAWING AND SUBMITTAL LOG

### Project: UMTH NORMAL POWER UPGRADE: PROJECT CP191241

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## Project: UMTH NORMAL POWER UPGRADE: PROJECT CP191241

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# CLOSEOUT LOG

**Project:** UMTH NORMAL POWER UPGRADE: PROJECT CP191241

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- Warranty
- Test Reports
- Test & Inspection Reports
- Field Quality-Control Test Reports
- System Demonstration Training
- Infrared Scanning report
Sustainability Report

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Total weight of all demolition material: __________

Percentage of total material diverted: __________
SECTION 1.F

INDEX OF DRAWINGS

Drawings referred to in and accompanying Project Manual consist of following sheets.

Sheet 1 of 28: COVER – PROJECT INFORMATION, SITE MAP, AND DRAWING INDEX
Sheet 2 of 28: A-001 – ARCHITECTURAL LEGEND
Sheet 3 of 28: A-002 – LIFE SAFETY PLAN
Sheet 4 of 28: A-101 – ARCHITECTURAL PLANS
Sheet 5 of 28: M-001 – MECHANICAL LEGEND
Sheet 6 of 28: M-101 – MECHANICAL PLANS
Sheet 7 of 28: M-501 – MECHANICAL DETAILS
Sheet 8 of 28: M-502 – MECHANICAL DETAILS
Sheet 9 of 28: M-701 – MECHANICAL CONTROLS
Sheet 10 of 28: M-702 – MECHANICAL CONTROLS
Sheet 11 of 28: P-001 – PLUMBING LEGEND
Sheet 12 of 28: P-101 – PLUMBING PLANS
Sheet 13 of 28: F-001 – FIRE PROTECTION LEGEND
Sheet 14 of 28: F-101 – FIRE PROTECTION PLANS
Sheet 15 of 28: E-001 – ELECTRICAL LEGEND
Sheet 16 of 28: E-101 – ELECTRICAL POWER PLANS – PHASE 1
Sheet 17 of 28: E-102 – ELECTRICAL POWER PLANS – PHASE 1
Sheet 18 of 28: E-103 – ELECTRICAL POWER PLANS – PHASE 2
Sheet 19 of 28: E-104 – ELECTRICAL POWER PLANS – PHASE 2
Sheet 20 of 28: E-105 – ELECTRICAL POWER PLANS – PHASE 2
Sheet 21 of 28: E-106 – ELECTRICAL POWER PLANS – PHASE 3
Sheet 22 of 28: E-107 – ELECTRICAL POWER PLANS – PHASE 3
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
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*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**
### OCCUPATIONAL TITLE

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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.*
SECTION 04 22 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section Includes:
      1. Concrete masonry units.
      2. Mortar and grout.
      3. Steel reinforcing bars.

1.03 RELATED REQUIREMENTS:

1.04 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. American Concrete Institute (ACI):
      1. ACI 315: Details and Detailing of Concrete Reinforcement.
   C. ASTM International (ASTM):
      1. ASTM A36 - Specification for Carbon Structural Steel.
      2. ASTM A82 - Specification for Steel Wire, Plain, for Concrete Reinforcement.
      4. ASTM A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete
         Reinforcement.
      5. 
      7. 
      8. ASTM C90 - Specification for Loadbearing Concrete Masonry Units.
          (Using 2-in. or 50-mm Cube Specimens).
      12. ASTM C140 - Test Methods for Sampling and Testing Concrete Masonry Units and
          Related Units.
      17. ASTM C270 - Specification for Mortar for Unit Masonry.
      20. ASTM C780 - Test Method for Preconstruction and Construction Evaluation of Mortars
          for Plain and Reinforced Unit Masonry.
      22. ASTM C1093 - Practice for Accreditation of Testing Agencies for Unit Masonry.
D. The Masonry Society (TMS), American Concrete Institute (ACI), and American Society of Civil Engineers (ASCE):
   1. TMS 402/ACI 530/ASCE 5 - Building Code Requirements for Masonry Structures.
E. National Concrete Masonry Association (NCMA):
   1. NCMA TEK 8-4A - Cleaning Concrete Masonry.
F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1.05 DEFINITIONS:
A. CMU(s): Concrete masonry unit(s).
B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.06 SUBMITTALS:
A. Product Data: For each type of product.
B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.
C. Qualification Data: For testing agency.
D. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include data on material properties and material test reports substantiating compliance with requirements.
   2. Cementitious materials. Include name of manufacturer, brand name, and type.
   3. Mortar admixtures.
   4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   5. Grout mixes. Include description of type and proportions of ingredients.
   6. Reinforcing bars.
   7. Joint reinforcement.
   8. Anchors, ties, and metal accessories.
E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with Property Specification. Test according to ASTM C109 for compressive strength, ASTM C1506 for water retention, and ASTM C91 for air content.
   2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.
F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
1.07 QUALITY ASSURANCE:
   A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.

1.08 DELIVERY, STORAGE, AND HANDLING:
   A. Store masonry units on elevated platforms in a dry location. If units are not stored in an
      enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If
      units become wet, do not install until they are dry.
   B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not
      use cementitious materials that have become damp.
   C. Store aggregates where grading and other required characteristics can be maintained and
      contamination avoided.
   D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry
      mortar mix in delivery containers on elevated platforms in a dry location or in covered
      weatherproof dispensing silos.
   E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of
      dirt and oil.

1.09 FIELD CONDITIONS:
   A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with
      waterproof sheeting at end of each day's work. Cover partially completed masonry when
      construction is not in progress.
      1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely
         in place.
   B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at
      least three days after building masonry walls or columns.
   C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left
      exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such
      masonry.
      1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading
         coverings on ground and over wall surface.
      2. Protect sills, ledges, and projections from mortar droppings.
      3. Protect surfaces of window and door frames, as well as similar products with painted and
         integral finishes, from mortar droppings.
      4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from
         splashing mortar and dirt onto completed masonry.
   D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with
      ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by
      frost or by freezing conditions. Comply with cold-weather construction requirements
      contained in TMS 602/ACI 530.1/ASCE 6.
      1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40°F
         (4°C) and higher and will remain so until masonry has dried, but not less than seven days
         after completing cleaning.
   E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in
      TMS 602/ACI 530.1/ASCE 6.
2.01 MANUFACTURERS:
   A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
   B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.02 UNIT MASONRY, GENERAL:
   A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
   B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet vertically and horizontally of a walking surface.
   C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

2.03 CONCRETE MASONRY UNITS:
   A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
      1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
      2. Provide bullnose units for outside corners unless otherwise indicated.
   B. CMUs: ASTM C90.
      1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2,800 psi. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.

2.04 MORTAR AND GROUT MATERIALS:
   A. Portland Cement: ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
      1. Alkali content shall not be more than 0.1% when tested according to ASTM C114.
   B. Hydrated Lime: ASTM C207, Type S.
   C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.
   D. Masonry Cement: ASTM C91.
   E. Mortar Cement: ASTM C1329.
      1. Aggregate for Mortar: ASTM C144.
         1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
         2. For joints less than 1/4 inch thick, use aggregate graded with 100% passing the No. 16 sieve.
         3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

2.05 REINFORCEMENT:
A. Uncoated Steel Reinforcing Bars: ASTM A615, Grade 60.
B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951.
1. Interior Walls: Hot-dip galvanized carbon steel.
2. Exterior Walls: Hot-dip galvanized carbon steel.
5. Spacing of Cross Rods: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.06 TIES AND ANCHORS:
A. General: Ties and anchors shall extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.
B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
2. Steel Plates, Shapes, and Bars: ASTM A36.

2.07 MISCELLANEOUS MASONRY ACCESSORIES:
A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35%; of width and thickness indicated; formulated from neoprene.
B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226, Type I (No. 15 asphalt felt).

2.08 MORTAR AND GROUT MIXES:
A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
2. Use Portland cement-lime or mortar cement mortar unless otherwise indicated.
B. Mortar for Unit Masonry: Comply with ASTM C270. Provide the following types of mortar for applications stated unless another type is indicated.
1. For interior partitions, Type S.
C. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, for specified 28-day compressive strength of 3,000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.
   4. Verify that substrates are free of substances that would impair mortar bond.
B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL:
A. Build chases and recesses to accommodate items specified in this and other Sections.
B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.03 TOLERANCES:
A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation, do not vary by more than +1/2 inch or -1/4 inch.
   2. For location of elements in elevation, do not vary from that indicated by more than ±1/4 inch in a story height or 1/2 inch total.
B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
   2. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
   3. 4. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.
C. Joints:
   1. For bed joints, do not vary from thickness indicated by more than ±1/8 inch, with a maximum thickness limited to 1/2 inch.

3.04 LAYING MASONRY WALLS:
A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets.
Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Fasten partition top anchors to structure above and build into top of partition. Grout top course of partition solidly.
   3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 43 - Joint Firestopping.

3.05 MORTAR BEDDING AND JOINTING:

A. Lay hollow CMUs as follows:
   1. Bed face shells in mortar and make head joints of depth equal to bed joints.
   2. Bed webs in mortar in all courses of piers, columns, and pilasters.
   3. Bed webs in mortar in grouted masonry, including starting course on footings.
   4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Rake out mortar joints at pre-faced CMUs to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

F. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.06 MASONRY-JOINT REINFORCEMENT:

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
1. Space reinforcement as indicated.
2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
C. Provide continuity at wall intersections by using prefabricated T-shaped units.
D. Provide continuity at corners by using prefabricated L-shaped units.

3.07 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE:
A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
   1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.08 CONTROL AND EXPANSION JOINTS:
A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
B. Form control joints in concrete masonry.

3.09 REINFORCED UNIT MASONRY INSTALLATION:
A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches.

3.10 FIELD QUALITY CONTROL:
A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
B. Inspections: Special inspections according to Level C in TMS 402/ACI 530/ASCE 5.
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.
D. Testing Frequency: One set of tests for each 5,000 sq. ft. (464 sq. m) of wall area or portion thereof.
E. Prism Test: For each type of construction provided, according to ASTM C1314 at at 28 days.

3.11 REPAIRING, POINTING, AND CLEANING:
A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
D. Final Cleaning:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3.12 MASONRY WASTE DISPOSAL:
A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project Site and legally dispose of off Owner's property.

END OF SECTION 04 22 00
SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Penetrations in fire-resistance-rated walls.
      2. Penetrations in horizontal assemblies.

1.03 RELATED REQUIREMENTS:
   A. Section 07 84 43 - Joint Firestopping for joints in or between fire-resistance-rated construction,
      at exterior curtain-wall/floor intersections, and in smoke barriers.

1.01 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. ASTM International:
      1. ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials
      2. ASTM E 814 - Test Method for Fire Tests of Penetration Firestop Systems
      3. ASTM E 2174 - On-Site Inspection of Installed Fire Stops
   C. California Department of Public Health:
         from Indoor Sources Using Environmental Chambers. 2010.
   D. FM Global:
      1. FM Global 4991-2001: Approval of Firestop Contractors
   E. Intertek Group:
   F. Underwriters Laboratories Inc. (UL):
      1. UL 1479-2003: Fire Tests of Through-Penetration Firestops (ANSI)
   G. Firestop Contractors International Association (FCIA):
         436, Hillside, IL 60162; 708-202-1108)

1.02 ALLOWANCES:
   A. Penetration firestopping Work is part of an allowance.

1.03 UNIT PRICES:
   A. Work of this Section is affected by unit prices.

1.04 PREINSTALLATION MEETINGS:
   A. Preinstallation Conference: Conduct conference at Project Site.

1.05 SUBMITTALS:
   A. Product Data: For each type of product.
B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

C. Qualification Data: For Installer.

D. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

E. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.06 QUALITY ASSURANCE:
   A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.07 PROJECT CONDITIONS:
   A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

   B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.08 COORDINATION:
   A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

   B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:
   A. Fire-Test-Response Characteristics:
      1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.

      2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
         a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
            (1) UL in its "Fire Resistance Directory."

2.02 PENETRATION FIRESTOPPING SYSTEMS:
   A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
SECTION 07 84 13 – PENETRATION FIRESTOPPING: CONTINUED

1. Hilti, Inc.
2. Isolatek International.
4. 3M Fire Protection Products.
5. Tremco, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch w.g. (2.49 Pa).
   1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch w.g. (2.49 Pa).
   1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
   2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
   3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
   1. Permanent forming/damming/backing materials.
   2. Substrate primers.
   3. Collars.
   4. Steel sleeves.

2.03 FILL MATERIALS:
A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
B. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.02 PREPARATION:
   A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
      1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
      2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
      3. Remove laitance and form-release agents from concrete.
   B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION:
   A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
   B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
      1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
   C. Install fill materials by proven techniques to produce the following results:
      1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
      2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
      3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION:
   A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
      1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).
      2. Wall identification to be stenciled.
   B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
      1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
      2. Contractor's name, address, and phone number.
      3. Designation of applicable testing and inspecting agency.
      4. Date of installation.
SECTION 07 84 13 – PENETRATION FIRESTOPPING: CONTINUED

5. Manufacturer’s name.
7. Installer’s name.

3.05 FIELD QUALITY CONTROL:
   A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
   B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
   C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION:
   A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
   B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.07 PENETRATION FIRESTOPPING SYSTEMS:
   A. Where UL-classified systems are indicated, they refer to system numbers in UL’s "Fire Resistance Directory" under product Category XHEZ.
      1. Refer to drawings for specific systems. If a penetration is encountered that does not fit under the parameters of the noted systems, please coordinate with manufacturer’s rep to obtain engineering judgements as needed.

END OF SECTION 07 84 13
PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Interior standard steel doors and frames.

1.03 RELATED REQUIREMENTS:
   A. Section 08 71 00 - Door Hardware for door hardware for hollow-metal doors.

1.04 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
      1. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      2. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      4. ASTM A 1008/A 1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
     10. ASTM E 136 - Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degree C.
   C. Builders Hardware Manufacturers Association (BHMA):
      1. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames (ANSI)
   D. Hollow Metal Manufacturers Association (Hemma); Division of National Association of Architectural Metal Manufacturers (NAAMM):
5. NAAMM-HMMA 867 - Guide Specifications for Commercial Laminated Core Hollow Metal Doors and Frames (ANSI).

E. National Fire Protection Association (NFPA):
1. NFPA 80 - Fire Doors and Other Opening Protectives (ANSI).
2. NFPA 105 - Smoke Door Assemblies and Other Opening Protectives (ANSI).
4. NFPA 257 - Fire Test for Window and Glass Block Assemblies (ANSI).

F. Steel Door Institute (SDI):
1. SDI 111C - Recommended Louver Details for Standard Steel Doors
2. SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames (ANSI).
3. SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors (ANSI).
4. SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames (ANSI).
5. SDI A250.8 - Specifications for Standard Steel Doors and Frames (ANSI).
6. SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames (ANSI).
7. SDI A250.11 - Recommended Erection Instructions for Steel Frames (ANSI).

G. Underwriters Laboratories Inc. (UL):
1. UL 9 - Fire Tests of Window Assemblies.
2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
3. UL 1784 - Air Leakage Tests of Door Assemblies and Other Opening Protectives.

1.05 DEFINITIONS:
A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.06 COORDINATION:
A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project Site in time for installation.
B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.07 SUBMITTALS:
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.
B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.
C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.
D. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.08 DELIVERY, STORAGE, AND HANDLING:
A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-Site storage. Do not use non-vented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.
B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
C. Store hollow-metal doors and frames vertically under cover at Project Site with head up. Place on minimum 4-inch (102-mm) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ceco Door; ASSA ABLOY.
   b. Curries Company; ASSA ABLOY.
   c. Steelcraft; an Allegion brand.
B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS:
A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.03 INTERIOR STANDARD STEEL DOORS AND FRAMES:
A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3; SDI A250.4, Level A.
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches (44.5 mm).
      c. Face: Metallic-coated, steel sheet, minimum thickness of 0.053 inch (1.3 mm).
      d. Edge Construction: Model 1, Full Flush.
      e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
      f. Core: Manufacturer's standard.
SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES: CONTINUED

2. Frames:
   a. Materials: Metallic-coated, steel sheet, minimum thickness of 0.053 inch (1.3 mm).
   b. Construction: Full profile welded.


2.04 FRAME ANCHORS:
A. Jamb Anchors:
   1. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch (9.5-mm) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.05 MATERIALS:
A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
D. Frame Anchors: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
G. Grout: ASTM C476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C143/C143M.
H. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
I. Glazing: Comply with requirements in Section 08 80 00 - Glazing.
J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.06 FABRICATION:
A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project Site, clearly identify work that cannot be permanently factory assembled before shipment.
B. Hollow-Metal Doors:
   1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Fire Door Cores: As required to provide fire-protection ratings indicated.

C. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

D. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same or greater thickness metal as frames.

1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

4. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Post-installed Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.

2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal work.

3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.07 STEEL FINISHES:

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
2.08 ACCESSORIES:
   A. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
   A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
   B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION:
   A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
   B. Hollow-Metal Frames: Comply with SDI A250.11.
      1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
         a. Install door silencers in frames before grouting.
         b. Remove temporary braces necessary for installation only after frames have been properly set and secured.
         c. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
         d. Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.
      2. At fire-rated openings, install frames according to NFPA 80.
      3. Floor Anchors: Secure with post-installed expansion anchors.
         a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
      4. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
      5. In-Place Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
      6. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
         a. Squareness: ±1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
         b. Alignment: ±1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES: CONTINUED

c. Twist: ±1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

d. Plumbness: ±1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below.

1. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements in Section 08 80 00 - Glazing and with hollow-metal manufacturer's written instructions.

3.04 ADJUSTING AND CLEANING:

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave Work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13
SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

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

1.02 SUMMARY:
A. This Section includes:
   1. Mechanical door hardware for the following:
      a. Swinging doors.
   2. Electrified door hardware.

1.03 RELATED SECTIONS:
A. Section 08 11 13 - Hollow Metal Doors and Frames for astragals provided as part of labeled fire-rated assemblies and for door silencers provided as part of hollow-metal frames.

1.04 REFERENCE STANDARDS:
A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American National Standards Institute/Steel Door Institute (ANSI/SDI):
   1. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
   2. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
C. ASTM International:
   1. ASTM E 283 - Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
D. Builders Hardware Manufacturers Association (BHMA):
   1. BHMA A156.1 - Butts and Hinges (ANSI).
   2. BHMA A156.2 - Bored and Preassembled Locks and Latches (ANSI).
   3. BHMA A156.3 - Exit Devices (ANSI).
   4. BHMA A156.4 - Door Controls - Closers (ANSI).
   5. BHMA A156.5 - Cylinders and Input Devices for Locks (ANSI).
   6. BHMA A156.6 - Architectural Door Trim (ANSI).
   7. BHMA A156.8 - Door Controls - Overhead Stops and Holders (ANSI).
   8. BHMA A156.12 - Interconnected Locks (ANSI).
  10. BHMA A156.14 - Sliding & Folding Door Hardware (ANSI).
  12. BHMA A156.16 - Auxiliary Hardware (ANSI).
  13. BHMA A156.17 - Self Closing Hinges & Pivots (ANSI).
  14. BHMA A156.18 - Materials and Finishes (ANSI).
  15. BHMA A156.21 - Thresholds (ANSI).
  16. BHMA A156.22 - Door Gasketing and Edge Seal Systems (ANSI).
  17. BHMA A156.23 - Electromagnetic Locks (ANSI).
  18. BHMA A156.24 - Delayed Egress Locking Systems (ANSI).
  19. BHMA A156.25 - Electrified Locking Devices (ANSI).
20. BHMA A156.26 - Continuous Hinges (ANSI).
22. BHMA A156.29 - Exit Locks, Exit Alarms, Alarms for Exit Devices (ANSI).
23. BHMA A156.30 - High Security Cylinders (ANSI).
24. BHMA A156.31 - Electric Strikes and Frame Mounted Actuators (ANSI).
25. BHMA A156.36 - Auxiliary Locks (ANSI).

E. Door and Hardware Institute (DHI):
   1. Recommended Locations for Architectural Hardware for Wood Flush Doors.

F. Hollow Metal Manufacturers Association (HMMA); Division of National Association of
   Architectural Metal Manufacturers (NAAMM):
   1. HMMA 831-2011: Recommended Hardware Locations for Custom Hollow Metal Doors
      and Frames

G. International Code Council (ICC):

H. National Electrical Manufacturers Association (NEMA):
   1. NEMA LD 3 - High Pressure Decorative Laminates (ANSI).

I. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code.
   2. NFPA 80 - Fire Doors and Other Opening Protectives.
   3. NFPA 105 - Standard Practice for the Installation of Smoke Door Assemblies and Other
      Opening Protectives.

J. Underwriters Laboratories Inc. (UL):
   1. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
   2. UL 1784 - Air Leakage Tests for Door Assemblies.

K. U.S. Department of Housing and Urban Development:
   1. Fair Housing Accessibility Guidelines.

L. U.S. Department of Justice:
   1. 2010 ADA Standards for Accessible Design.

M. U.S. Department of Transportation:
   1. ADA Standards for Transportation Facilities.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated. Include construction and installation details,
   material descriptions, dimensions of individual components and profiles, and finishes.

B. Other Action Submittals:
   1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing
      fabrication and assembly of door hardware, as well as installation procedures and
      diagrams. Coordinate final door hardware schedule with doors, frames, and related work
      to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. Submittal Sequence: Submit door hardware schedule concurrent with submissions
         of Product Data, Samples, and Shop Drawings. Coordinate submission of door
         hardware schedule with scheduling requirements of other work to facilitate the
         fabrication of other work that is critical in Project construction schedule.
      b. Format: Use same scheduling sequence and format and use same door numbers as
         in the Contract Documents.
      c. Content: Include the following information:
         (1) Identification number, location, hand, fire rating, size, and material of each
             door and frame.
(2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.

(3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

(4) Fastenings and other pertinent information.

(5) Explanation of abbreviations, symbols, and codes contained in schedule.

(6) Mounting locations for door hardware.

(7) List of related door devices specified in other sections for each door and frame.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

C. Qualification Data: For Installer and Architectural Hardware Consultant.

D. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

E. Warranty: Special warranty specified in this Section.

F. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

1.06 QUALITY ASSURANCE:

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.

2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:

1. For door hardware, an Architectural Openings Consultant (AOC).

C. Source Limitations: Obtain each type of door hardware from a single manufacturer.

D. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

E. Means of Egress Doors: Latches do not require more than 15 lbf. (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

F. Accessibility Requirements: Comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design and ICC A117.1 for door hardware on doors in an accessible route.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf. (22.2 N).

2. Comply with the following maximum opening-force requirements:

   a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf. (22.2 N) applied perpendicular to door.

   b. Sliding or Folding Doors: 5 lbf. (22.2 N) applied parallel to door at latch.

   c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
4. Closers: Adjust door and gate closer sweep periods so that, from an open position of 90 degrees, the time required to move the door to a position of 12 degrees from the latch is 5 seconds minimum.
5. Spring Hinges: Adjust door and gate spring hinges so that, from an open position of 70 degrees, the time required to move the door to the closed position is 1.5 seconds minimum.

G. Keying Conference: Conduct conference at Project Site to comply with requirements in Section 01 31 00 - Project Management and Coordination. In addition to Owner, Construction Manager, Contractor, and Architect, conference participants shall also include Installer's Architectural Openings Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Requirements for key control system.
4. Requirements for access control.
5. Address for delivery of keys.

1.07 DELIVERY, STORAGE, AND HANDLING:
A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project Site.
B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
D. Deliver keys[ and permanent cores] to Owner by registered mail or overnight package service.

1.08 COORDINATION:
A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
C. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.09 WARRANTY:
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures including excessive deflection, cracking, or breakage.
   b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.
   a. Exit Devices: Two years from date of Substantial Completion.
   b. Manual Closers: 10 years from date of Substantial Completion.

1.10 MAINTENANCE SERVICE:
   A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE:
   A. Provide door hardware for each door as scheduled on Drawings to comply with requirements in this Section.
      1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
   B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
      1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.

2.02 Hinges:
   A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

2.03 MECHANICAL LOCKS AND LATCHES:
   A. Lock Functions: As indicated in door hardware schedule.
   B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
      1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
   C. Lock Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
   D. Lock Trim:
      1. Description: As indicated on Drawings.
      2. Levers: Cast.
      4. Dummy Trim: Match lever lock trim and escutcheons.
      5. Operating Device: Lever with escutcheons (roses).
   E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
      1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
   F. Bored Locks: BHMA A156.2; Grade 1; Series 4000.
2.04 **EXIT DEVICES AND AUXILIARY ITEMS:**
   A. Exit Devices and Auxiliary Items: BHMA A156.3.

2.05 **LOCK CYLINDERS:**
   A. Lock Cylinders: Supplied by Owner.

2.06 **KEYING:**
   A. Keys: Supplied by Owner.

2.07 **OPERATING TRIM:**
   A. Operating Trim: BHMA A156.6; aluminum, unless otherwise indicated.

2.08 **ACCESSORIES FOR PAIRS OF DOORS:**
   A. Astragals: BHMA A156.22.

2.09 **SURFACE CLOSERS:**
   A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.10 **DOOR GASKETING:**
   A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

2.11 **THRESHOLDS:**
   A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.12 **METAL PROTECTIVE TRIM UNITS:**
   A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch (1.3-mm) thick aluminum; with manufacturer's standard machine or self-tapping screw fasteners.

2.13 **FABRICATION:**
   A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.
      1. Manufacturer's identification is permitted on rim of lock cylinders only.
   B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
   C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
1. Fire-Rated Applications:
   a. Steel Through Bolts: For the following unless door blocking is provided:
      (1) Surface hinges to doors.
      (2) Closers to doors and frames.
      (3) Surface-mounted exit devices.
2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.14 FINISHES:
   A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
   B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
   A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.03 INSTALLATION:
   A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
   B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.
      1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
      2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
   C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
SECTION 08 71 00 – DOOR HARDWARE: CONTINUED

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
   1. Replace construction cores with permanent cores as directed by Owner.
E. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
F. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00 - Joint Sealants.
G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.04 FIELD QUALITY CONTROL:
A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
   1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.05 ADJUSTING:
A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.06 CLEANING AND PROTECTION:
A. Clean adjacent surfaces soiled by door hardware installation.
B. Clean operating items as necessary to restore proper function and finish.
C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

END OF SECTION 08 71 00
PART 1 - GENERAL

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

1.02 SUMMARY:
A. This Section includes coating of exterior and interior surfaces throughout the Project and which are listed in Part 2, with systems specified on "coating system" sheets at the end of this Section.
B. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.
1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
3. Concealed surfaces subject to corrosion or attack if unprotected shall be prime-coated and touched up prior to concealment under insulation or other protective layer.
4. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.

1.03 RELATED REQUIREMENTS:
A. Shop Painting and Coatings: All applicable Divisions.
B. Factory Prefinished Items: All applicable Divisions.
C. Colors:
   1. Color of finish coatings shall match adjacent.
   2. When second and finish coats of a system are of same type, tint or use an alternate color on second coat to enable visual coverage inspection of the third coat. When first and second coats only are specified and are of same or different types, tint or use an alternate color on first coat to enable visual coverage inspection of the second coat.

1.04 REFERENCE STANDARDS:
A. Applicable Standards:
   1. American National Standards Institute (ANSI):
   2. ASTM International (ASTM):
      a. ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
      b. ASTM D4258 - Surface Cleaning Concrete for Coating.
      c. ASTM D4259 - Abrading Concrete.
      d. ASTM D4260 - Acid Etching Concrete.
      e. ASTM D4261 - Surface Cleaning Concrete Unit Masonry for Coating.
   3. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
a. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.
b. SP2 - Hand Tool Cleaning: Remove loose material. Not intended to remove adherent mill scale, rust, and paint.
c. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.
d. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
e. SP6 - Commercial Blast Cleaning: Two-thirds of every 9 inches² free of all visible residues; remainder only light discoloration.
f. SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.
g. SP10 - Near-White Blast Cleaning: At least 95% of every 9 inches² shall be free of all visible residues.
h. SP11 - Power Tool Cleaning to Bare Metal.
i. SP12 - Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
j. SP13 - Surface Preparation of Concrete.

4. National Sanitation Foundation (NSF):
a. 61 - Drinking Water Treatment Chemicals - Health Effects.

1.05 SUBMITTALS:
A. Submit as specified in Division 01.
B. Includes, but not limited to, the following:
   1. Schedule of products and paint systems to be used. Schedule shall include the following information:
      a. Surfaces for system to be applied.
      b. Surface preparation method and degree of cleanliness.
      c. Product manufacturer, name, and number.
      d. Method of application.
      e. Dry film mil thickness per coat of coating to be applied.
   2. Color charts for selection and acceptance.
   3. Technical and material safety data sheets.
   4. Certification(s) by coating manufacturer(s) that all coatings are suitable for service intended as stated on each coating system sheet. If manufacturer has an equivalent product as that specified, and it is suitable for the intended purpose, Contractor shall submit the recommended product for approval at no increase in cost, and state reasons for substitution.
   5. Contractor shall certify in writing to the Engineer/Architect that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.

1.06 QUALITY ASSURANCE:
A. Include on label of container:
   1. Manufacturer's name, product name, and number.
   2. Type of paint and generic name.
   3. Color name and number.
4. Storage and temperature limits.
5. Mixing and application instructions, including requirements for precautions which must be taken.
6. Drying, recoat, or curing time.

B. A coating report shall be completed daily by Contractor at each phase of the coating system starting with surface preparation. These shall be submitted on the form attached at end of this Section.

C. In the event a problem occurs with coating system, surface preparation, or application, Contractor shall require coating applicator and coating manufacturer's technical representative to promptly investigate the problem and submit results to Engineer/Architect.

D. Specified VOC shall mean unthinned maximum VOC certified by manufacturer. VOC content as a result of thinning shall not exceed that allowed by federal or local environmental regulations.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Delivery of Materials:
   1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.
   2. Allow sufficient time for testing if required.

B. Storage of Materials:
   1. Store only acceptable materials on Project Site.
   2. Provide separate area and suitable containers for storage of coatings and related coating equipment.
   3. Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

1.08 REGULATORY REQUIREMENTS:

A. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the U.S. EPA and the local and regional jurisdictions. Notify Engineer/Architect of any coating specified herein that fails to conform to the requirements for the location of the Project or location of application.

B. Lead Content: Use only coatings that are totally lead free.

C. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.

D. Asbestos Content: Materials shall not contain asbestos.

E. Mercury Content: Materials shall not contain mercury or mercury compounds.

1.09 PROJECT CONDITIONS:

A. This Project is in an academic teaching hospital. All precautions shall be taken to prevent paint odors from leaving the construction area.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Proprietary names and product numbers are specified in most systems for material identification from these manufacturers:
SECTION 09 90 00 – PROTECTIVE COATINGS: CONTINUED

1. Carboline Company, Inc.
2. Devoe Coating Company, Division of ICI.
4. PPG Industries Inc.
5. Sherwin-Williams.
6. Tnemec Company, Inc.
8. Rust-Oleum.

2.02 GENERAL:
A. Materials furnished for each coating system must be compatible to the substrate.
B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions.

2.03 COATING SYSTEMS:
A. Specified on the "Protective Coating System" sheets at the end of this Section.

2.04 SURFACES TO BE COATED:
A. System Primer-1 VOC: Shop-applied primer, unless otherwise noted.
   1. Structural steel not exposed to view or not indicated to be finish painted.
B. System B-1:
   1. Interior nonferrous and galvanized metal indicated to be painted.
C. System F-1:
   1. Concrete or CMU Walls and Ceilings.
D. Concrete floors exposed due to demolition.
   1. Hillyard Concrete Primer and MT Concrete Seal.
      a. Install per manufacturer’s recommendations.
      b. One coat of primer, two coats of MT Concrete Seal or as recommended by manufacturer.

2.05 SURFACES NOT TO BE COATED:
A. Surfaces that are prefinished or already finish painted.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:
A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.
   1. If grease or oils are present, SSPC SP1 shall precede any other method specified for metal substrates.
   2. Remove surface irregularities such as weld spatter, burrs, or sharp edges prior to specified surface preparation.
B. Depth of profile will be as specified or as recommended by the manufacturer for each system, but in no instance shall it exceed one-third of the total dry film thickness of complete system.
C. Prepare only those areas which will receive the first coat of the system on the same day.
   1. On steel substrates, apply coating before rust bloom forms.
D. Concrete and masonry surfaces shall be adequately cured prior to coating application.
   1. Use surface cleaning methods, followed by mechanical or chemical surface preparation as specified in SSPC SP13.
   2. Acid etching (ASTM D 4260) shall not be used for vertical surfaces.
   3. Acid etching shall only be used where:
      4. Procedures are in place for removal of acid residues and the handling, containment, and disposal of hazardous materials.
   5. Measures for protection of worker health and safety are provided.
E. For new galvanized steel to be coated, if absence of hexavalent stain inhibitors is not documented, test as described in ASTM D2092, Appendix X2, and remove by one of the methods described therein.

3.02 APPLICATION:
A. Apply coatings in accordance with coating manufacturer's recommendations.
B. Use properly designed brushes, rollers, and spray equipment for all applications.
C. On unprimed surfaces apply first coat of the system the same day as surface preparation.
D. Dry film thickness of each system shall meet the minimum specified. Maximum dry film thickness shall not exceed the minimum more than 20% or coating manufacturer's requirements if less. Where a dry film thickness range is specified, the range shall not be less than or exceeded.
E. Shop and field painting shall remain 3 inches (75 mm) away from unprepared surface of any substrate such as areas to be welded or bolted.
F. Environmental Conditions:
   1. Atmospheric temperature must be 50ºF (10ºC) or higher during application, unless otherwise approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating recoat cure times.
   2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.
   3. Relative humidity must be less than 85%. The ambient temperature and the temperature of the surface to be painted must be at least 5ºF (2.8ºC) above the dew point.
   4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
G. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the applied coating in accordance with manufacturer's recommendations.
H. Protection:
   1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
   2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
   3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical Equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.
   4. Provide signs to indicate fresh paint areas.
5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers which cannot be reused in accordance with applicable regulations.

6. Do not remove or paint over Equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 INSPECTION:
   A. Contractor shall provide and use a wet film gauges to check each application approximately every 15 min. in order to immediately correct film thickness under or over that specified.
   B. Contractor shall provide and use a dry film gauge to check each coat mil (mm) thickness when dry, and the total system mil (mm) thickness when completed.
   C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
   D. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.
   E. Check air temperature and temperature of the substrate at regular intervals to be certain surface is 5°F (2.8°C) or more above the dew point.

3.04 CLEANING AND REPAIRS:
   A. Remove spilled, dripped, or splattered paint from surfaces.
   B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

END OF SECTION 09 90 00
## SECTION 09 90 00 – PROTECTIVE COATINGS: CONTINUED

### PROTECTIVE COATING SYSTEM

**System:** Primer-1 VOC

<table>
<thead>
<tr>
<th>SERVICE:</th>
<th>Steel &amp; Cast Iron - Normal Exposure (Nonimmersion) Exterior or Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Preparation:</td>
<td>Shop: SSPC-SP6 and profile depth 1.0 to 1.5 mils (.025 to 0.038 mm). Field Touch Up (of Shop-applied first coat): SSPC-SP11</td>
</tr>
<tr>
<td>Shop (Prime) Coat:</td>
<td>Water-based acrylic with minimum 35% solids by volume. Apply at 2.0 – 4.0 mils dry film thickness.</td>
</tr>
<tr>
<td>Touch Up</td>
<td>Field: Touch-up same as first coat with color as primer.</td>
</tr>
<tr>
<td>System Total:</td>
<td>Minimum 2.0 mils dry film thickness.</td>
</tr>
<tr>
<td>Volatile Organic Content:</td>
<td>Maximum 250 g/L (each coat)</td>
</tr>
</tbody>
</table>

### COATING MANUFACTURER

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>PRODUCT DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRST COAT</strong></td>
<td><strong>TOUCH UP</strong></td>
</tr>
<tr>
<td>Carboline</td>
<td>Carbocrylic 3358</td>
</tr>
<tr>
<td>Devoe – AkzoNobel</td>
<td>Devflex 4020PF</td>
</tr>
<tr>
<td>International</td>
<td>Intercryl 520</td>
</tr>
<tr>
<td>PPG</td>
<td>Pitt-Hide Plus 90-912</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>Pro-Cryl B66-310</td>
</tr>
</tbody>
</table>
### SERVICE:
Nonferrous & Galvanized Metal — Normal Exposure (Nonimmersion)
Exterior or Interior (Except Galvanized Handrail)

### Surface Preparation:
Shop or field first coat: Remove oil or soap film with neutral detergent or emulsion cleaner. Surface shall be clean and dry.

### Pretreatment:
Pretreat galvanized metal with zinc treatment such as "Galvaprep" or as recommended by coating manufacturer. Pretreat other nonferrous metals as recommended by coating manufacturer.

### Touch Up
Touch up small areas of galvanized surface with zinc touch up material such as "ZRC Cold Galvanizing Compound" or as recommended by coating manufacturer. Large damaged galvanized areas shall receive surface preparation and coating of organic zinc-rich primer as recommended by coating manufacturer.

### First Coat:
High build polyamide or polyamidoamine epoxy with minimum 65% solids by volume. Apply at 4.0 to 6.0 mils (100 to 150 microns) dry film thickness.

### Second Coat:
High solids aliphatic acrylic polyurethane gloss enamel with minimum 55% solids by volume. Apply at 2.0 to 3.0 mils (50 to 75 microns minimum dry film thickness.

### System Total:
Minimum 6.0 mils (150 microns) dry film thickness.

### Volatile Organic Content:
Maximum 150 VOC g/L (each coat)

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>PRODUCT DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRETREATMENT</strong></td>
<td><strong>TOUCHUP</strong></td>
</tr>
<tr>
<td>Carboline</td>
<td>See above</td>
</tr>
<tr>
<td>Devoe - AkzoNobel</td>
<td>See above</td>
</tr>
<tr>
<td>PPG</td>
<td>See above</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>See above</td>
</tr>
</tbody>
</table>
**SERVICE:** Concrete, Concrete Masonry Units (CMU) - Normal Exposure Exterior (Nonimmersion) Interior

**Surface Preparation:** Concrete: ASTM D4258, clean and dry. Fill pits in concrete with patching compound as recommended by coating manufacturer. CMU: ASTM D4261, clean and dry.

**Touch-Up:** Field: Touch-up same as first coat with color as primer.

**First Coat:** (CMU) High solids masonry block filler with minimum 50% solids by volume. Apply as required to fill pores on CMU.

**Second Coat:** Water-base acrylic epoxy gloss enamel with minimum 40% solids by volume. Apply at 2.0 to 2.5 mils (50 to 63 microns) dry film thickness.

**Third Coat:** Same as second coat. Note: Second and third coats may be applied in one 4.0 to 5.0 mil (100 to 125 microns) coat if allowed by coating manufacturer.

**System Total:** Minimum 4.0 mils (100 microns) dry film thickness in addition to block filler.

**Volatile Organic Content:** Maximum 50 g/L Blockfiller/Primer 150 g/L finish coats

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>FIRST COAT</th>
<th>TOUCH UP</th>
<th>SECOND COAT</th>
<th>THIRD COAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carboline</td>
<td>Sanitile 500</td>
<td>See above</td>
<td>Carbocrylic 3359 DTM</td>
<td>Carbocrylic 3359 DTM</td>
</tr>
<tr>
<td>Devoe - AkzoNobel</td>
<td>Bloxfill 4000</td>
<td>See above</td>
<td>WB Tru-Glaze 4428</td>
<td>WB Tru-Glaze 4428</td>
</tr>
<tr>
<td>International</td>
<td>Intercryl 320</td>
<td>See above</td>
<td>InterH₂O735</td>
<td>InterH₂O735</td>
</tr>
<tr>
<td>PPG</td>
<td>Pitt-Glaze 16-90</td>
<td>See above</td>
<td>Pitt-Glaze WB 16-551 Series</td>
<td>Pitt-Glaze WB 16-551 Series</td>
</tr>
</tbody>
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PART 1 - GENERAL

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

1.02 SUMMARY:
A. This Section includes:
1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.03 REFERENCES:
A. Applicable Standards (Latest Edition):
1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
2. American Society of Sanitary Engineering (ASSE):
3. ASME International (ASME):
   a. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
4. ASTM International (ASTM):
   d. ASTM A536 - Specification for Ductile Iron Castings.
   h. ASTM C1540 - Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
5. Cast Iron Soil Pipe Institute (CISPI):
7. International Association of Plumbing and Mechanical Officials (IAPMO):
   a. IAPMO PS 66 - Dielectric Waterway Fittings.
8. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
   a. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
b. MSS SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube.
9. NSF International (NSF):
   a. NSF/ANSI 14 - Plastics Piping System Components and Related Materials.

1.04 PERFORMANCE REQUIREMENTS:
   A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

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

1.06 INFORMATIONAL SUBMITTALS:
   A. Field quality-control reports.

1.07 QUALITY ASSURANCE:
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.08 PROJECT CONDITIONS:
   A. Interruption of Existing Sanitary Waste Service: Refer to Division 01.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTING:
   A. Pipe and Fittings: ASTM A888 or CISPI 301.
   B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
   C. CISPI, Hubless-Piping Couplings
      2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
   D. Cast-Iron, Hubless-Piping Coupling
      2. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.03 SPECIALTY PIPE FITTINGS:
   A. Transition Couplings:
      1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
PART 3 - EXECUTION

3.01 PIPING INSTALLATION:
   A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on coordination drawings.
   B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
   C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless specifically indicated otherwise.
   D. Install piping at indicated slopes.
   E. Install piping free of sags and bends.
   F. Install fittings for changes in direction and branch connections.
   G. Install piping to allow application of insulation.
   H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
   I. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
      1. Building Sanitary Drain: 2% downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2% downward in direction of flow for piping NPS 4 (DN 100) and larger.
      2. Horizontal Sanitary Drainage Piping: 2% downward in direction of flow.

3.02 JOINT CONSTRUCTION:
   A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.03 SPECIALTY PIPE FITTING INSTALLATION:
   A. Transition Couplings:
      1. Install transition couplings at joints of piping with small differences in ODs.
      2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.04 HANGER AND SUPPORT INSTALLATION:
   A. Comply with requirements for pipe hanger and support devices and installation specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
      1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
      2. Vertical Piping: MSS Type 8 or Type 42 clamps.
      3. Install individual, straight, horizontal piping runs:
         a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
         b. Longer than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
         c. Longer than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
SECTION 22 13 16 – SANITARY WASTE AND VENT PIPING: CONTINUED

4. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
5. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
   3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32): 84 inches (2,100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2,700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
H. Install supports for vertical steel piping every 15 feet (4.5 m).
I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.05 CONNECTIONS:
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.06 FIELD QUALITY CONTROL:
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.07 CLEANING AND PROTECTION:
   A. Clean interior of piping. Remove dirt and debris as work progresses.
   B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
   C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.08 PIPING SCHEDULE:
   A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
   B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be the following:
      1. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
   C. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be the following:
      1. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.

END OF SECTION 22 13 16
SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 REFERENCE STANDARDS:
   A. Applicable Standards (latest edition):
      1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      2. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      3. National Electrical Manufacturers Association (NEMA):
         a. NEMA MG 1 - Motors and Generators

1.04 COORDINATION:
   A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
      1. Motor controllers.
      2. Torque, speed, and horsepower requirements of the load.
      3. Ratings and characteristics of supply circuit and required control sequence.
      4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCT

2.01 GENERAL MOTOR REQUIREMENTS:
   A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
   B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS:
   A. Duty: Continuous duty at ambient temperature of 40º and at altitude of 3300 feet above sea level.
   B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
2.03 POLYPHASE MOTORS:
   A. Description: NEMA MG 1, Design B, general purpose, continuous duty, insulation class H.
   B. Efficiency: 90% efficient, as defined in ASHRAE Standard 90A.
   C. Service Factor: 1.15.
   D. Rotor: Random-wound, squirrel cage.
   E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
   F. Temperature Rise: Match insulation rating.
   G. Insulation: Class F.
   H. Code Letter Designation:
      1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
      2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
   I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS:
   A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
      1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
      2. Bearing Protection: All motors operated on variable frequency drives shall be equipped with maintenance free, 360 degree circumferential conductive micro fiber shaft grounding ring with a minimum two continuous rows of conductive micro fibers completely surrounding the motor shaft to discharge electrical shaft voltages away from the motor’s bearings to ground. Note: Friction/spring contact brushes shall not be acceptable.
      3. Application Note: Motors up to 100HP shall be provided with a minimum of one shaft grounding ring as described above installed by the manufacturer internally to the motor or externally on the drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer’s recommendations.
      4. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
      5. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
      6. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS:
   A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
      1. Permanent-split capacitor.
      2. Split phase.
      3. Capacitor start, inductor run.
      4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
D. Motors 1/20 HP and Smaller: Shaded-pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 13
SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT: CONTINUED

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PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Test plugs.
      2. Liquid-in-glass thermometers.
      3. Thermowells.

1.03 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Editions):
      1. ASME International (ASME):
         a. ASME B1.1 - Unified Inch Screw Threads, UN and UNR Thread Form.
         b. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
         c. ASME B40.100 - Pressure Gauges and Gauge Attachments.
         d. ASME B40.200 - Thermometers, Direct Reading and Remote Reading.

1.04 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 TEST PLUGS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. National Meter, Inc.
      2. Peterson Equipment Co., Inc.
      4. Trerice, H. O. Co.
      5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   B. Description: Test-station fitting made for insertion into piping tee fitting.
   C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
   D. Thread Size: NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
   E. Minimum Pressure and Temperature Rating: 500 psig at 200ºF (3450 kPa at 93ºC).
   F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.02 LIQUID-IN-GLASS THERMOMETERS:
   A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers: requirements, provide products by one of the following:
      a. Trerice, H. O. Co.
      b. Owner approved equal.
   3. Case: Cast aluminum; 6 inch nominal size.
   4. Case Form: Back angle, unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in °F.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
10. Accuracy: ±1% of scale range or one scale division, to a maximum of 1.5% of scale range.

2.03 THERMOWELLS:
   A. Thermowells:
      2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
      3. Material for Use with Copper Tubing: CNR or CUNI.
      4. Material for Use with Steel Piping: CRES.
      5. Type: Stepped shank, unless straight or tapered shank is indicated.
      6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
      7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
      8. Bore: Diameter required to match thermometer bulb or stem.
      9. Insertion Length: Length required to match thermometer bulb or stem.
     10. Lagging Extension: Include on thermowells for insulated piping and tubing.
     11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
   B. Heat-Transfer Medium: Mixture of graphite and glycerin.

PART 3 - EXECUTION

3.01 INSTALLATION:
   A. Install test plugs in piping tees.
   B. Install connection fittings in accessible locations for attachment to portable indicators.
   C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
   D. Install thermowells with extension on insulated piping.
   E. Fill thermowells with heat-transfer medium.
   F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

3.02 CONNECTIONS:
   A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING:
   A. After installation, calibrate meters according to manufacturer's written instructions.
   B. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE:
   A. Scale Range for Chilled-Water Piping: 0 to 100°F

END OF SECTION 23 05 19
SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

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

1.02 SUMMARY:
A. This Section includes:
1. Bronze ball valves.
2. Bronze swing check valves.

1.03 RELATED REQUIREMENTS:
A. DIVISION 23 - HVAC Piping Sections for specialty valves applicable to those sections only.
B. SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT for valve tags and schedules.

1.04 REFERENCE STANDARDS:
A. Applicable Standards (Latest Edition):
   1. American Water Works Association (AWWA):
      a. AWWA C606 - Grooved and Shouldered Joints.
   2. ASME International (ASME):
      a. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
      b. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
      c. ASME B16.34 - Valves - Flanged, Threaded, and Welding End.
      d. ASME B31.9 - Building Services Piping.
   3. ASTM International (ASTM):
      a. ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
   4. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
      a. MSS SP-45 - Bypass and Drain Connections.
      b. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
      c. MSS SP-110 - Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.05 DEFINITIONS:
A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. RS: Rising stem.

1.06 SUBMITTALS:
A. Product Data: For each type of valve indicated.

1.07 QUALITY ASSURANCE:
A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.
1.08 DELIVERY, STORAGE, AND HANDLING:
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES:
A. Refer to HVAC valve schedule articles for applications of valves.
B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
C. Valve Sizes: Same as upstream piping, unless otherwise indicated.
D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.
E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
F. Valve-End Connections:
   1. Threaded: With threads according to ASME B1.20.1.
G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES:
A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Milwaukee Valve Company.
      d. Victaulic
      e. Nibco
   2. Description:
      b. SWP Rating: 150 psig (1035 kPa).
      c. CWP Rating: 600 psig (4140 kPa).
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented for compressed air service.
j. Port: Full.

2.03 BRONZE SWING CHECK VALVES:
A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

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

3.03 ADJUSTING:
A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.
3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:
   A. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
   B. Select valves, except wafer types, with the following end connections:
      1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.05 CHILLED-WATER VALVE SCHEDULE:
   A. Pipe NPS 2 and Smaller:
      1. Ball Valves: Two piece, full port, bronze with stainless-steel trim. May be provided with solder-joint ends instead of threaded ends.
      2. Bronze Swing Check Valves: Class 150, nonmetallic disc.

END OF SECTION 23 05 23
SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Pipe stands.

1.02 RELATED REQUIREMENTS:
1. SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation devices.

1.03 REFERENCE STANDARDS:
A. Applicable Standards (Latest Edition):
   1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
   2. American Welding Society (AWS):
      a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   3. ASME International (ASME):
      a. ASME B31.9 - Building Services Piping.
      b. ASME Boiler and Pressure Vessel Code - Section IX, "Welding and Brazing Qualifications."
   4. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      c. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
      e. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   5. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
      b. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
      c. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
   6. Metal Framing Manufacturers Association, Inc. (MFMA):
      a. MFMA-103 - Guidelines for the Use of Metal Framing.
   7. The Society for Protective Coatings (SSPC):
      a. SSPC-PA 1 - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.

1.04 DEFINITIONS:
A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

1.05 PERFORMANCE REQUIREMENTS:
A. Delegated Design:
1. Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. For each pipe steam, pumped and gravity condensate hanger, anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.
3. Anchor Details: Detail fabrication of each anchor required. Show dimensions and methods of assembly and attachment to building structure.

B. Alignment Guide Details: Detail field assembly and attachment to building structure.
C. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment.

1.06 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
      1. Trapeze pipe hangers.
      2. Metal framing systems.
      3. Pipe stands.
   C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
      1. Detail fabrication and assembly of trapeze hangers.
      2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.07 QUALITY ASSURANCE:
   A. Structural Steel Welding Qualifications: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   B. Pipe Welding Qualifications: Weld piping in accordance with qualified procedures using performance qualified welders and welding operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS:
   A. Carbon-Steel Pipe Hangers and Supports:
      1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - Execution), factory-fabricated components.
      2. Galvanized Metallic Coatings: Pre-galvanized or hot-dipped.
      3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
      4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - Execution), factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - Execution), copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

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

2.03 THERMAL HANGER SHIELD INSERTS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Carpenter & Paterson, Inc.
      2. PHS Industries, Inc.
      3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
      4. Owner Approved Equal.
   B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
   C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig (688-kPa); ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.
   D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
   E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
   F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS:
   A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 MISCELLANEOUS MATERIALS:
   A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
   B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
      2. Design Mix: 5,000-psi, 28-day compressive strength.
PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION:
   A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
   B. The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, 12, 16, 19, 20, 23, 25, 27, 28, 29, and 30. However, Types 7, 9, 10, 11, 19, and 23 may be used for nonferrous and plastic piping systems 2 inches and smaller.
   C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
      1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
      2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
   D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
   E. Fastener System Installation:
      1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Do not use in lightweight concrete or in concrete slabs less than 4 inches thick. Powder activated fasteners will not be permitted.
   F. Pipe Stand Installation:
      1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
      2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
   G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
   H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   I. Install lateral bracing with pipe hangers and supports to prevent swaying.
   J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
   K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
   L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.02 EQUIPMENT SUPPORTS:
   A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
   B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
   C. Provide lateral bracing, to prevent swaying, for equipment supports.
3.03 **METAL FABRICATIONS:**

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with qualified procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 **ADJUSTING:**

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 **PAINTING:**

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in DIVISION 09.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.06 **HANGER AND SUPPORT SCHEDULE:**

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

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

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

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

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

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

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, and 12. However, Types 7, 9, 10, and 11 may be used for nonferrous and plastic piping systems 2 inches and smaller.
   2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT:
continued

3. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050°F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
4. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
5. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
8. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
9. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
10. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
11. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
12. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
13. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
14. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
15. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Exception: The following figure type given in Figure 1 of MSS SP-69 will not be acceptable: Type 16.
2. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
3. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
4. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F piping installations.

J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following type
1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: 19, 20, 23, 25, 27, 28, 29, 30, and 34.
2. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 pounds.
   b. Medium (MSS Type 32): 1,500 pounds.
   c. Heavy (MSS Type 33): 3,000 pounds.
6. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
7. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

L. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29
SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Equipment labels.
      2. Pipe labels.
      3. Valve tags.
      4. Warning tags.

1.03 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Edition):
      1. ASME International (ASME):

1.04 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Samples: For color, letter style, and graphic representation required for each identification material and device.
   C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
   D. Valve numbering scheme.
   E. Valve Schedules: For each piping system to include in maintenance manuals.

1.05 COORDINATION:
   A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   B. Coordinate installation of identifying devices with locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:
   A. Metal Labels for Equipment:
      1. Material and Thickness: Stainless steel, 0.025 inch (0.64 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
      2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inches (64 by 19 mm).
      3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
      5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
2.02 PIPE LABELS:
   A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
   B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
   C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
      1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
      2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.03 VALVE TAGS:
   A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
      1. Tag Material: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
      2. Fasteners: Brasswire-link chain.

PART 3 - EXECUTION

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

3.02 EQUIPMENT LABEL INSTALLATION:
   A. Install or permanently fasten labels on each major item of mechanical equipment.
   B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION:
   A. Piping Color-Coding: Painting of piping is specified in DIVISION 09.
   B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      1. Near each valve and control device.
      2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
      4. At access doors, manholes, and similar access points that permit view of concealed piping.
      5. Near major equipment items and other points of origination and termination.
      6. Spaced at maximum intervals of 50 ft. (15 m) along each run. Reduce intervals to 25 ft. (7.6 m) in areas of congested piping and equipment.
   C. Pipe Label Color Schedule:
      1. Chilled Water Piping:
         a. Background Color: Yellow.
         b. Letter Color: Black.
3.04 VALVE-TAG INSTALLATION:
   A. Install tags on valves and control devices in piping systems, except check valves; valves within
      factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering
      hose connections; and HVAC terminal devices and similar roughing-in connections of end-use
      fixtures and units. List tagged valves in a valve schedule.
   B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and
      with captions similar to those indicated in the following subparagraphs:
      1. Valve-Tag Size and Shape:
         a. Chilled Water: 1-1/2 inches (38 mm), round.

END OF SECTION 23 05 53
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SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

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

1.02 PROJECT CONDITIONS:
   A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB
      period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's
      operations.

1.03 DESCRIPTION OF WORK:
   A. This scope of services specifies the requirements and procedures for mechanical systems
      testing, adjusting, and balancing. Requirements include measurement and establishment
      of the fluid quantities of the mechanical systems as required to meet design specifications and
      recording and reporting the results. The test and balance work will be performed by the
      Owner’s personnel. It is the Contractor’s responsibility to assist as outlined below.
   B. Test, adjust and balance the following mechanical systems which are shown in the
      construction documents.
      1. Supply air systems, all pressure ranges, including variable volume and constant volume
         systems.
      2. Return air systems
      3. Exhaust Air Systems
      4. Hydronic systems.
      5. Verify temperature control system operation.
   C. The contractor’s responsibilities are as follows:
      1. Notify the Owner’s Representative fourteen (14) days prior to the schedule date
         for balancing the system.
      2. Schedule a two (2) week allowance for the testing and balancing firm to
         complete the testing and balancing work when scheduling completion of all
         work required of the Contractor by the contract documents.
      3. Cooperate with the testing and balancing firm and shall make all necessary
         preparations for the TAB efforts.
      4. Complete the following work prior to requesting the TAB effort.
         a. Clean and flush all piping systems.
         b. Leak test and make tight all piping systems.
         c. Fill all piping systems with clean water.
         d. Clean and seal all ductwork systems.
         e. Service and tag all equipment.
         f. Set and align all motors and drives.
         g. Start up and prove all equipment and systems.
         h. Make preliminary settings on all control devices and have all
            systems operational.
         i. Lubricate all motors and bearings.
         j. Check fan belt tension.
         k. Check fan rotation.
         l. Operate all systems successfully for twenty-four (24) hours minimum.
      5. Patch insulation, ductwork and housing, using materials identical to those removed.
      6. Seal insulation to re-establish integrity of the vapor barrier.
7. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
8. Provide a complete set of as-built drawings prior to the TAB effort.
9. Provide craftsmen of the proper trade to work with the TAB firm to make adjustments and installation changes as required.
10. Change out fan sheaves when and if required by the TAB firm.
11. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
12. If a significant rebalance (Owner’s determination) of the HVAC system is required due to the Contractor’s failure to properly install and check out the HVAC system, the cost of rebalancing the system shall be borne by the Contractor.

1.04 PRE-BALANCING CONFERENCE:
A. Prior to beginning of the testing, adjusting and balancing procedures, a conference with the Owner’s representative, Engineer and the Test and Balance Agency’s representative will be held. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

1.05 SEQUENCING AND SCHEDULING OF SERVICES
A. Test, adjust and balance the air conditioning systems during summer season and heating systems during winter season. This includes at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer design condition, and within 10 deg. F dry bulb temperature of minimum winter design conditions. Take final temperature readings during seasonal operation.

1.06 COORDINATION:
A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
B. Notice: Provide seven days’ advance notice for each test. Include scheduled test dates and times.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 93
SECTION 23 07 13 – DUCT INSULATION

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes requirements for insulating sheet metal ductwork.

1.03 RELATED REQUIREMENTS:
   A. Section 23 07 19 - HVAC Piping Insulation.

1.04 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Edition):
      1. ASTM International (ASTM):
         d. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
         e. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
         f. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
         g. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
         h. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
         k. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
      2. California Department of Health Services:
      4. Military Specifications (MIL):
SECTION 23 07 13 – DUCT INSULATION: CONTINUED

1.05 SUBMITTALS:
   A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and field-applied jackets (if any).
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
      2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
      3. Detail application of field-applied jackets.
      4. Detail application at linkages of control devices.
   C. Qualification Data: For qualified Installer.
   D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
   E. Field quality-control reports.

1.06 QUALITY ASSURANCE:
   A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
   B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
      1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
      2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 DELIVERY, STORAGE, AND HANDLING:
   A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.08 COORDINATION:
   A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
   B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
   C. Coordinate installation and testing of heat tracing.

1.09 SCHEDULING:
   A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
   B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
SECTION 23 07 13 – DUCT INSULATION: CONTINUED

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:
   B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
   D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
   E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         a. CertainTeed Corp.; SoftTouch Duct Wrap.
         b. Johns Manville; Microlite.
         c. Knauf Insulation; Friendly Feel Duct Wrap.
         d. Owens Corning; SOFTR All-Service Duct Wrap.
         e. Owner approved equal.
   F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with FSK factory-applied jacket.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         a. CertainTeed Corp.; Commercial Board.
         b. Fibrex Insulations, Inc.; FBX.
         c. Johns Manville; 800 Series Spin-Glas.
         d. Knauf Insulation; Insulation Board.
         e. Owens Corning; Fiberglas 700 Series.

2.02 ADHESIVES:
   A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
   B. Mineral-Fiber Board or Blanket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         b. Eagle Bridges - Marathon Industries; 225.
         d. Mon-Eco Industries, Inc.; 22-25.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
b. Eagle Bridges - Marathon Industries; 225.
d. Mon-Eco Industries, Inc.; 22-25.

2.03 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: -20 to +180ºF (-29 to +82ºC).
4. Solids Content: ASTM D1644, 58% by volume and 70% by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   b. Eagle Bridges - Marathon Industries; 501.
   d. Mon-Eco Industries, Inc.; 55-10.
2. Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
3. Service Temperature Range: 0 to 180ºF (-18 to +82ºC).

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: -20 to +180°F (-29 to +82ºC).
4. Solids Content: 60% by volume and 66% by weight.

2.04 SEALANTS:
A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide products by one of the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 FACTORY-APPLIED JACKETS:
A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.

2.06 TAPES:
A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.07 SECUREMENTS:
A. Bands:
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; CWP-1.
      (2) GEMCO; CD.
      (3) Midwest Fasteners, Inc.; CD.
      (4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch (3.5-mm) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; CHP-1.
      (2) GEMCO; Cupped Head Weld Pin.
      (3) Midwest Fasteners, Inc.; Cupped Head.
      (4) Nelson Stud Welding; CHP.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick, galvanized-steel or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; RC-150.
      (2) GEMCO; R-150.
      (3) Midwest Fasteners, Inc.; WA-150.
      (4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      (1) GEMCO.
      (2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch (19-mm) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS:
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
H. Install insulation with least number of joints practical.
I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3 inch (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
L. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS:
A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.
B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
   4. Seal jacket to wall flashing with flashing sealant.
C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
   1. Comply with requirements in DIVISION 07.

3.05 INSTALLATION OF MINERAL-FIBER INSULATION:
A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.

b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25-mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50°F (10°C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch (150-mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches (150-mm) o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16-inches (400-mm) o.c.

b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16-inches (400-mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25-mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50°F (10°C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the face. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch (150-mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches (150-mm) o.c.

3.06 DUCT INSULATION SCHEDULE, GENERAL:
A. Plenums and Ducts Requiring Insulation:
   1. Indoor supply ductwork.
   2. Electrical room outside air ductwork
B. Items Not Insulated:
   1. Flexible connectors.
   2. Vibration-control devices.
   3. Factory-insulated access panels and doors.
   4. Outside air duct in return air plenums
   5. Return air duct in return air plenums

3.07 ABOVEGROUND INDOOR DUCT AND PLENUM INSULATION SCHEDULE:
A. Indoor supply and outside air duct insulation in plenums shall be the following:
   1. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.5-lb./cu. ft. (24-kg/cu. m) nominal density.
B. Indoor supply and outside air duct insulation in electrical rooms shall be the following:
   1. Mineral-Fiber Board: 2 inches (50mm) thick and 3-lb./cu.ft (48-kg/cu.m) nominal density.

END OF SECTION 23 07 13
SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Section includes insulating the following HVAC piping systems:
      1. Chilled-water piping, indoors.

1.03 REFERENCES:
   A. Applicable Standards (Latest Edition):
      2. ASTM International (ASTM):
         b. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
         c. ASTM C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
         d. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
         e. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
         f. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
         g. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
         j. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
      3. California Department of Health Services:
      5. Military Specifications (MIL):
         b. MIL-C-20079H - Cloth, Glass; Tape, Textile Glass and Thread, Glass and Wire-Reinforced Glass.
         c. MIL-PRF-19565C - Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor Barrier.

1.04 ACTION SUBMITTALS:
SECTION 23 07 19 - HVAC PIPING INSULATION: continued

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.05 INFORMATIONAL SUBMITTALS:
A. Qualification Data: For qualified Installer.
B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.06 QUALITY ASSURANCE:
A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.07 DELIVERY, STORAGE, AND HANDLING:
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.08 COORDINATION:
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT.
B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
C. Coordinate installation and testing of heat tracing.

1.09 SCHEDULING:
A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
SECTION 23 07 19 - HVAC PIPING INSULATION: continued

F. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

G. Insulation thickness shall comply with ASHRAE 90.1 or the table below whichever is greater.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell, LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

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

2.03 INSULATING CEMENTS:
A. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

2.04 ADHESIVES:
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 MASTICS:
A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: -20 to +180ºF (-29 to -82ºC).
3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
   2. Service Temperature Range: 0 to 180°F (-18 to +82°C).

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   2. Service Temperature Range: -20 to +180°F (-29 to +82°C).
   3. Solids Content: 60% by volume and 66% by weight.

2.06 SEALANTS:
A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: -100 to +300°F (-73 to +149°C).

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: -40 to +250°F (-40 to +121°C).

C. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.07 TAPES:
A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2%.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.08 SECUREMENTS:
A. Bands:
   1. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch (19 mm) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION:
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.03 GENERAL INSTALLATION REQUIREMENTS:
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
G. Keep insulation materials dry during application and finishing.
H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
I. Install insulation with least number of joints practical.
J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch (75-mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.04 PENETRATION:
A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):
   Install insulation continuously through walls and partitions.

B. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.05 GENERAL PIPE INSULATION INSTALLATION:
A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable
insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
SECTION 23 07 19 - HVAC PIPING INSULATION: continued

4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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

3.08 FIELD QUALITY CONTROL:
   A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   B. Perform tests and inspections.
   C. Tests and Inspections:
      D. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.09 PIPING INSULATION SCHEDULE, GENERAL:
   A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.10 PIPING INSULATION SCHEDULE:
   A. Insulation for
      1. Indoor Chilled Water:
         a. Flexible Elastomeric: 1 inch (25mm) thick

END OF SECTION 23 07 19
PART 1 GENERAL

1.1 DESCRIPTION

A. The purpose of this section is to specify the Contractor’s responsibilities and participation in the commissioning process relative to Division 23.

B. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Commissioning is primarily the responsibility of the Commissioning Authority, with start-up, testing and support for commissioning the responsibility of the Contractors. The commissioning process does not relieve the Contractor from participation in the process or diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner.

C. Work of Division 23 includes:

1. Testing and start-up of the HVAC equipment.
3. Providing qualified personnel to assist in commissioning tests, including seasonal testing.
4. Completion and endorsement of Pre-functional Construction Checklists provided by the Commissioning Authority to assure that Division 23 equipment and systems are fully operational and ready for functional testing.
5. Providing equipment, materials and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
6. Provide a detailed start up plan for Commissioning Authority’s review, comment and recommendation.
7. Provide at the end of the job the following items for inclusion in the systems manual.
   a. Control drawings, sequences of control
   b. A table of all set points
   c. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown
   d. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.
8. Providing operation and maintenance information and as-built drawings to the Commissioning Authority for review, verification and organization, prior to distribution.
9. Providing assistance to the Commissioning Authority to develop, edit and document system operation descriptions.
10. Providing training for the systems specified in this Division with coordination of Owner by the Commissioning Authority.
1.2 RELATED WORK

A. All installation, testing and start-up procedures and documentation requirements specified within Division 23.

B. Section 019113 – Commissioning

C. Commissioning Functional Test Procedures that required participation of the Division 23 Contractors.

D. Cooperate with the Commissioning Authority in the following manner:
   1. All testing and start-up procedures and documentation requirements specified within Division 1 and Division 23 and related portions of this project.
   2. Allow sufficient time before final completion dates so mechanical systems start-up, test and balance and commissioning can be accomplished.
   3. Provide labor and material to make corrections when required without undue delay.
   4. Put all heating, ventilation and air conditioning systems and equipment into full operation and continue the operation of the same during each working day of the testing, balancing and commissioning.
   5. Include the costs of the dampers, replacement sheaves and belts, as required, to obtain satisfactory system performance as requested by the test and balance contractor or the Commissioning Authority
   6. Provide test holes in ducts and plenums where directed or necessary for pitot tubes for taking air measurements and to balance the air systems. Test holes shall be provided with an approved removable plug or seal. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.
   7. Provide pressure/temperature taps where directed or necessary for taking measurements to test and balance hydronic systems.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Standard test equipment for commissioning will be provided by the Contractor.

B. Division 23 Contractor shall provide standard and specialized test equipment as necessary to test and start up the HVAC systems.

C. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment through the installing contractor. Manufacturer shall provide the test equipment, demonstrate its use and assist the Commissioning Authority in the commissioning process.

D. The Contractor shall provide all equipment, software and all test programming support as necessary to start up, calibrate, debug and verify proper function of the control/facility management system. This equipment and software shall be provided for use by both the test and balance contractor and the Commissioning Authority.
3.1 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the systems can be energized, started, tested and otherwise commissioned. Division 23 has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are functional. This includes the complete installation of all equipment materials, raceways, wire, terminations, controls, etc., per the Contract Documents and related directives, clarifications, change orders, etc.

B. A Commissioning Plan will be developed by the Commissioning Authority. Upon request of the Commissioning Authority, the Contractor shall provide assistance and consultation. The Commissioning Plan will be developed prior to completion of the installation. The Contractor is obligated to assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor-initiated system changes have been made that alter the commissioning process, the Commissioning Authority will notify the Architect and the Contractor may be obligated to compensate the Commissioning Authority to test the revised product or confirm the suitability/unsuitability of the substitution or revision.

C. Specific pre-commissioning responsibilities of Division 23 are as follows:

1. Normal start-up services required bringing each system into a fully operational state. This includes motor rotational check cleaning, lug tightening, control sequences of operation, etc. The Commissioning Authority will not begin the commissioning process until each system is complete, including normal contractor start-up and debugging.

2. The Contractor shall perform pre-functional construction checklists on the systems to be commissioned to verify that all aspects of the work are complete in compliance with the plans and Specifications. Contractor start-up forms may be substituted for the pre-functional test forms with prior approval by the Commissioning Authority.

3. Factory start-up services will be provided for key equipment and systems specified in Division 23. Factory start-up activities to be documented and submitted. The Contractor shall coordinate this work with the manufacturer and the Commissioning Authority.

4. Notify Construction Manager and Commissioning Authority when systems are ready for functional testing.

D. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems and/or sub-systems, if expediting this work is in the best interests of the Owner. Commissioning activities and schedule will be coordinated with the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.
3.2 PARTICIPATION IN COMMISSIONING

A. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Provide skilled technicians to start up and debug all systems within this division of work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments and/or problem resolutions.

B. System problems and discrepancies may require additional technician time, Commissioning Authority time, redesign and/or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system and/or subsystem. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purpose of this work.

D. The test, adjust and balance subcontractor shall provide a draft report with final test measurements to the Commissioning Authority and shall provide qualified technicians and instruments needed for balancing to demonstrate a sample of up to 100% of measurements until specified results are achieved.

3.3 WORK TO RESOLVE DEFICIENCIES

A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet the original design intent. Correction of work will be completed under direction of the Architect, with input from the Contractor, equipment supplier and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate and work out problems, the Architect/Engineer of Record will have final jurisdiction on the necessary work to be done to achieve performance.

3.4 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor, suppliers and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.
B. The cost of compensation of the Commissioning Authority for repeat testing or troubleshooting due to systems that do not meet specified performance shall be borne by the Contractor.

C. Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely to the commissioning process, the Commissioning Authority will notify the Architect/Engineer of Record indicating the nature of the problem, expected steps to be taken and the deadline for completion of activities. If the deadline passes without resolution of the problem, the Owner reserves the right to obtain supplementary services and equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor’s responsibility.

3.5 TRAINING

A. This Contractor will be required to participate in the training of the Owner’s engineering and maintenance staff for each system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner’s option.

3.6 SYSTEMS DOCUMENTATION

A. Maintain as-built red-lines on the job site as required in Division 1. Given the size and complexity of this project, red-lining of the drawings at completion of construction based on memory of key personnel is not satisfactory. Continuous and regular red-lining and/or posting of drawings is considered essential and mandatory.

B. In addition to the stated requirements for operation and maintenance data, provide one (1) copy of equipment technical literature, operation and maintenance literature and shop drawings to the Commissioning Authority as soon as they are available. This requirement is for review of these documents prior to distribution of multiple copies for the Owner’s final use.

C. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown

D. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.

3.7 SOFTWARE

A. The Controls Contractor shall supply the Commissioning Authority with an unprotected electronic controls submittal with all flow diagrams, sequence of operation, bill of materials and point database in Microsoft Visio or AutoCAD format in time for use in preparing the functional test procedures and integrated one-line diagrams.

B. The Controls Contractor shall supply the Commissioning Authority with two (2) debugged printouts of all facility management systems software, including all user’s
programming and engineering manuals required to interpret the software. Included in the
printouts, though not limited to, shall be the following:

1. Point data base
2. All custom control programs written in the BAS control language
3. All parameters required for proper operation of BAS control and utility firmware
   such as start/stop routines, etc.
4. System graphics

C. The software printout shall be fully documented for ease of interpretation by the
Commissioning Authority and Owner without assistance from the Contractor. English
language descriptions shall be either integrated with or attached to the BAS printout. The
following shall be specifically documented:

1. All point names, I/O and virtual.
2. All BAS programming language commands, functions, syntax, operators and
   reserved variables.
3. Use of all BAS firmware.
4. The intended actions, decisions and calculations of each line or logical group of
   lines in the custom control program(s). Sequences of operation alone are not
   sufficient.
5. Complete descriptions of and theories explaining all software and firmware
   algorithms. The algorithms to be described include, but are not limited to, PID,
   optimum start/stop, demand limiting and chiller and boiler optimization.
6. A table of contents to the documentation that locates the sections of the
   documentation and describes which programs or program sections are for each
   piece of controlled/monitored equipment.
7. Flow charts using IEEE symbol nomenclature that demonstrates the software’s
   algorithms and flow logic.

END OF SECTION
PART 1 - GENERAL

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

1.02 SUMMARY: UNIVERSITY OF MISSOURI CONTROLS SPECIFICATION
   A. This section contains requirements for pneumatic, electric and digital control systems as
      indicated on the contract drawings.
   B. Contractor is responsible for providing, installing and connecting all sensors, pneumatic
      actuators, control valves, control dampers, electrical components and all interconnecting
      pneumatic tubing and electrical wiring between these devices and up to the Direct Digital
      Controller (DDC).
   C. DDC controllers consist of Johnson Controls METASYS controllers, type NAE, DX, FEC,
      IOM, AHU, VAV, VMA, or UNT controllers. Owner will provide Johnson Controls
      METASYS controllers for the contractor to install.
   D. After all equipment has been installed, wired and piped, Owner will be responsible for all
      termination connections at the DDC controller’s and for checking, testing, programming and
      start-up of the control system. Contractor must be on site at start-up to make any necessary
      hardware adjustments as required.
   E. Once each mechanical system is completely operational under the new control system,
      contractor shall make any final connections and adjustments. For controls renovation jobs,
      contractor shall remove all unused sensors, operators, panels, wiring, tubing, conduit, etc.
      Owner shall have the option of retaining any removed pneumatic controls.

1.03 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Edition):
      1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
         a. ASHRAE 135 - BACnet - A Data Communication Protocol for Building
            Automation and Control Networks.
      2. NEMA – National Electric Manufacturers Association
      3. NFPA:
         b. NFPA 90 - Standard for the Installation of Air-Conditioning and Ventilating
            Systems
      4. Underwriter Laboratories (UL)

1.04 DEFINITIONS:
   A. DDC: Direct digital control.
   B. I/O: Input/output.

1.05 SEQUENCE OF OPERATION:
   A. Refer to project drawings.

1.06 SUBMITTALS:
   A. Shop Drawings: Submit shop drawings for each control system, containing the following
      information:
      1. Product data for each damper, valve, and control device.
SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC: CONTINUED

2. Schematic flow diagrams of system showing fans, pumps, coils, dampers, valves, and control devices.
3. Label each control device with setting or adjustable range of control.
4. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Provide details of faces on control panels, including controls, instruments, and labeling.
6. Include written description of sequence of operation.
7. Provide wiring diagrams of contractor provided interface and I/O panels.

1.07 QUALITY ASSURANCE:
A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with ASHRAE 135 for DDC system components.
D. Comply with NEMA standards pertaining to components and devices for control systems.

1.08 COORDINATION:
A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Contractor's Qualifications: 1. Contractor shall be regularly engaged in the installation of digital control systems and equipment, of types and sizes required. Contractor shall have a minimum of five years experience installing digital control systems. Contractor shall supply sufficient and competent supervision and personnel throughout the project in accordance with General Conditions.
B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

2.02 CONDUIT AND RACEWAY:
A. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3
B. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.
C. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment.
D. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.

2.03 CONTROL VALVES:
A. Provide factory fabricated electric control valves of type, body material, and pressure class as indicated on the drawings. Butterfly style control valves are not acceptable except for two position applications. Equip control valves with heavy-duty actuators, with proper shutoff rating for each individual application.
B. Hydronic Chilled Water and Heating Water. Automatic Pressure Independent Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Griswold Controls.
   c. Hays Fluid Control.
   d. Owner approved equal

2. Flow Control valves shall be factory set to rated flow. Each automatic balancing valve shall automatically control the flow rate to within ±5% of its rated flow, over a temperature range of 32°F to 225°F, and a pressure differential range of 2 to 80 psig. Valves shall have the capabilities and pressure ratings as indicated and conform to this specification.

3. Body: Brass or ferrous metal.

4. Flow Control Assembly shall be one of the following types:
   a. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
   b. Precision sculptured brass or polyphenylsulfone orifice with an elastomeric diaphragm.

5. Combination Assemblies: Include bronze or brass-alloy ball valve.

6. Identification Tag: Marked with zone identification, valve number, and flow rate.

7. Size: Same as pipe in which installed.

8. Performance: Maintain constant flow, ±5% over system pressure fluctuations.


10. Maximum Operating Temperature: 250°F.

2.04 ACTUATORS:

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Section 23 05 13 – "Common Motor Requirements for HVAC Equipment."

2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. by lbf (16.9 N by m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Belimo Aircontrols (USA), Inc.
   b. Johnson Controls
   c. Bray
   d. TAC
   e. Owner approved equal.
   f. KCM Actuators are not approved.

2. Dampers: Size for running torque calculated as follows:
a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return): 120Vac.
7. Proportional Signal: 0 to 10Vdc, and 0 to 10Vdc position feedback signal.
8. Temperature Rating: -22 to +122ºF.
9. Run Time: 12 seconds open, 5 seconds closed.

C. Actuators with integral damper end switch are acceptable. For VAV reheat valves, actuators shall have a manual override capability to aid in system flushing, startup, and balancing.

2.05 ELECTRONIC TEMPERATURE SENSORS AND TRANSMITTERS:

A. Chilled Water Sensors
1. General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Tower/Hot Water and steam temperatures in a mechanical room environment.
2. Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. Results are to be programmed into the transmitter. Results are to be presented on report as after condition at the specified calibration points. Assembly shall not be approved for installation until Owner has received all factory calibration reports.
3. RTD:
   a. RTD type: 2-wire or 3-wire 100 ohm platinum class A
   b. Outside Diameter: 0.25 inch
   c. Tolerance: +/- 0.06% Type A
   d. Stability: +/- 0.1 % over one year.
   e. TCR: 0.00385 (ohm/ohm/°C).
   f. RTD shall be tip sensitive.
   g. Resistance vs. Temperature table for the RTD must be provided to the Owner.
4. Transmitter:
   a. Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
   b. Type: 2 wire (loop powered)
   c. Input: 2 or 3 wire 100 ohm platinum class A or class B RTD
   d. Output: Output shall be a 4-20 mA signal linear to temperature
   e. Calibrated Span:
      (1) Chilled Water: 30 °F to 130 °F.
      (2) Tower Water: 30 °F to 130 °F.
      (3) Hot Water: 100 °F to 250 °F.
      (4) Steam: 150 °F to 450 °F
   f. Calibration Accuracy, including total of all errors, of the Transmitter & RTD matched pair over the entire span shall be within +/- 0.2% of the calibrated span or +/- 0.18 °F, whichever is greater.
   g. Supply Voltage: 24 VDC.
   h. Ambient Operating Temp.: 32 to 122 °F
   i. Epoxy potted for moisture resistance.
   j. Mounting: Transmitter shall be mounted in the RTD connection head.
5. Thermowell
   a. Thermowell shall be suitable for immersion in chilled/hot water and steam.
   b. Thermowell shall be reduced tip.
   c. Thermowell shall be one piece stainless steel machined from solid bar stock.
   d. Thermowell shall have 1/2” NPT process connection to pipe thread-o-let.
   e. Thermowell Insertion depth shall be ½ the inside pipe diameter but not to exceed 10”.

6. Assembly:
   a. Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.
   b. Connection head shall be cast aluminum with chain connecting cap to body, have 1/2” NPT process and 3/4” NPT conduit connections, and a sealing gasket between cap and body.

7. RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:
   a. Manufacturer: Pyromation, Inc.
   b. Chilled Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(30-130)F with calibration SMC(40,60)F

2.06 FAN/PUMP STATUS:
   A. Status points for fan motors with a VFD must be connected to the terminal strip of the VFD for status indication.
      1. Current switches: Current switches are required for fan statuses that are not connected to a VFD. The switches must have an adjustable trip setpoint with LED indication and be capable of detecting broken belts or couplings.
      2. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty.
      3. Kele, Hawkeye or approved equal.
      4. Relays Used for Fan and Pump Start/Stop: Must have LED indication and be mounted externally of starter enclosure or VFD.
         a. Kele, RIBU1C or approved equal.

2.07 DAMPERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Ruskin CD-50
      2. Owner approved equal.
   B. Provide dampers with parallel blades for 2- position control.
   C. Provide opposed blades for modulating control.
   D. Dampers shall be low leakage design with blade and edge seals.
   E. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.

2.08 POWER SUPPLY
   A. Power Supply Used to Provide Power to Contractor-Provided Control Devices: Shall have adjustable DC output, screw terminals, overload protection and 24 VAC and 24 VDC output.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Kele, DCPA-1.2
2.09 DIFFERENTIAL PRESSURE TRANSMITTER  
A. Differential Pressure Transmitter: Provide units with linear analog 4-20mA output proportional to differential pressure, compatible with the Johnson METASYS Systems.  
B. Air: Units shall be capable of measuring a differential pressure of 0 to 5 in. WC. Accuracy shall be +/- 1.0% full scale with a compensated temperature range of 40 to 149 deg F and a maximum working pressure of 250 psig.  
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
      a. Setra model 267  
      b. Owner approved equal.  
   2. Shall be installed in control panel and piped 2/3 down the duct unless shown otherwise or approved by owners representative.

2.10 HIGH STATIC PRESSURE LIMIT SWITCH  
A. Provide pressure high limit switch to open contact in fan circuit to shut down the supply fan when the inlet static pressure rises above the set point. Provide with an adjustable set point, a manual reset button, 2 SPST (normally closed) contacts, and ¼” compression fittings.  
   1. Kele model AFS-460-DDS, or approved equal.

2.11 AIRFLOW/TEMPERATURE MEASUREMENT DEVICES  
A. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.  
B. The measurement device shall consist of one or more sensor probe assemblies and a single, remotely mounted, microprocessor-based transmitter. Each sensor probe assembly shall contain one or more independently wired sensor housings. The airflow and temperature readings calculated for each sensor housing shall be equally weighted and averaged by the transmitter prior to output. Pitot tubes and arrays are not acceptable. Vortex shedding flow meters are not acceptable.  
C. All Sensor Probe Assemblies  
   1. Each sensor housing shall be manufactured of a U.L. listed engineered thermoplastic.  
   2. Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature. Devices that use “chip” or diode case type thermistors are unacceptable. Devices that do not have 2 thermistors in each sensor housing are not acceptable.  
   3. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/-2% of reading over the entire operating airflow range. Each sensor housing shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).  
   4. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.  
   5. The operating temperature range for the sensor probe assembly shall be -20° F to 160 F. The operating humidity range for the sensor probe assembly shall be 0-99% RH (non-condensing).  
   6. Each temperature sensor shall be calibrated at a minimum of 3 temperatures and have an accuracy of +/-0.15° F over the entire operating temperature range. Each temperature
sensor shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
7. Each sensor probe assembly shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
8. Each sensor assembly shall not require matching to the transmitter in the field.
9. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.

D. Duct and Plenum Sensor Probe Assemblies
1. Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly. Thermistor probes shall be mounted in sensor housings using a waterproof marine grade epoxy resin. All wires within the aluminum tube shall be Kynar coated.
2. The number of sensor housings provided for each location shall be as follows:
   a. Area (sq.ft.) | Sensors
      <2           | 4
      2 to <4      | 6
      4 to <8      | 8
      8 to <16     | 12
      >=16         | 16
3. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
   a. Insertion mounted through the side or top of the duct.
   b. Internally mounted inside the duct or plenum.
   c. Standoff mounted inside the plenum.
4. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

E. Fan Inlet Sensor Probe Assemblies
1. Sensor housings shall be mounted on 304 stainless steel blocks.
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.
4. The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.

F. Transmitters
1. The transmitter shall have a 16 character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics. Configuration settings and diagnostics shall be accessed through a pushbutton interface on the main circuit board. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.
2. The transmitter shall be capable of independently monitoring and averaging up to 16 individual airflow and temperature readings. The transmitter shall be capable of displaying the airflow and temperature readings of individual sensors on the LCD display.
3. The transmitter shall have a power switch and operate on 24 VAC (isolation not required). The transmitter shall use a switching power supply fused and protected from transients and power surges.
4. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
5. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
6. The transmitter shall be capable of communicating with the host controls using one of the following interface options:
7. Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire).
8. RS-485: Field selectable BACnet-MS/TP, ModBus-RTU and Johnson Controls N2 Bus.
9. 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, ModBus-TCP and TCP/IP.
10. LonWorks Free Topology.
11. The transmitter shall have an infra-red interface capable of downloading individual sensor airflow and temperature data or uploading transmitter configuration data to a handheld PDA (Palm or Microsoft Pocket PC operating systems).
12. The measuring device shall be UL listed as an entire assembly.
13. The manufacturer’s authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer’s placement requirements.
14. Manufacturer
   a. Primary flow elements, sensors, meters and transducers shall be EBTRON, Inc. Model GTx116-P and GTx116-F or approved equal.
   b. The naming of any manufacturer does not automatically constitute acceptance of this standard product nor waive their responsibility to comply totally with all requirements of the proceeding specification.
G. Electrical Requirements: Provide electric-pneumatic switches, electrical devices, and relays that are UL-listed and of type which meet current and voltage characteristics of the project. All devices shall be of industrial/ commercial grade or better. Residential types will be rejected.
1. EP Switches: Landis & Gyr Powers, Inc. Series 265 - Junction Box Type or approved equal.
2. Relays: Relays shall have an LED status indicator, voltage transient suppression, Closed-Open-Auto switch, plastic enclosure, and color coded wires. Kele model RIBU1C or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Verify that power supply is available to control units and operator workstation.
   B. Verify that duct-, and equipment-mounted devices are installed before proceeding with installation.

3.02 INSTALLATION:
   A. Install raceways, boxes, and cabinets according to Division 26.
   B. Raceway: Raceway is to be installed in accordance with the National Electric Code. Use of flexible metal conduit or liquidtight flexible conduit is limited to 36" to connect from EMT to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.
   C. Control Wiring: Install control wiring in raceway, without splices between terminal points, color-coded. Install in a neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
1. Install circuits over 25-volt with color-coded No. 12 stranded wire.
2. Install electronic circuits and circuits under 25-volts with color-coded No. 18 stranded twisted shielded pair type conductor.
3. N2 communications bus wire shall be 18 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 18-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent. a) Metastat wiring shall be minimum 20 AWG, plenum rated, stranded, 8 conductor stranded wire.
4. FC communications bus wire shall be 22 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 22-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent a) Network sensor wiring (SA Bus) shall be 22 gauge plenum rated stranded twisted wire, 4 conductor..
5. All control wiring at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel. Label all control wires per bid documents

D. All low voltage electrical wiring shall be run as follows:
1. Route electrical wiring in concealed spaces and mechanical rooms whenever possible.
2. Provide EMT conduit and fittings in mechanical rooms and where indicated on drawings.
3. Low voltage electrical wiring routed above acoustical ceiling is not required to be in conduit, but wire must be plenum rated. Clip wire to structural ceiling.
4. Provide surface raceway, fittings and boxes in finished areas where wiring cannot be run in concealed spaces. Route on ceiling or along walls as close to ceiling as possible. Run raceway parallel to walls. Diagonal runs are not permitted. Paint raceway and fittings to match existing conditions. Patch/repair/paint any exposed wall penetrations to match existing conditions.

E. Devices:
1. Adjustable thermostats shall be provided with base and covers in occupied areas and mounted 48" above finished floor to the top of the device. Tubing and/or wiring shall be concealed within the wall up to the ceiling where ever possible. Surface raceway may only be used with approval of Owners Representative. Wall mounted sensors such as CO2, RH, and non-adjustable temperature sensors shall be mounted 54" above finished floor. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.
2. All control devices shall be tagged and labeled for future identification and servicing of control system.
3. All field devices must be accessible or access panels must be installed.

F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.03 ADJUSTING AND STARTUP
A. Start-Up: Temporary control of Air Handling Units shall be allowed only if approved by the owner’s representative to protect finishes, etc., AHUs may be run using caution with temporary controls installed by contractor early in the startup process. All safeties including a smoke detector for shut down must be operational. Some means of discharge air control shall be utilized and provided by the contractor such as a temporary temperature sensor and controller located and installed by the Contractor.

B. The start-up, testing, and adjusting of digital control systems will be conducted by owner. Once all items are completed by the Contractor for each system, Contractor shall allow time in the
construction schedule for owner to complete commissioning of controls before project substantial completion. This task should be included in the original schedule and updated to include the allotted time necessary to complete it. As a minimum, the following items are required to be completed by the Contractor for Owner to begin controls commissioning.

C. Process Control Network
   1. The control boards and enclosures need to be installed in the mechanical rooms.
   2. The fiber optic conduit and box for the process control network needs to be installed. Once in place, Owner needs to be contacted so the length of the owner provided fiber cable can be determined and ordered, if required. Coordinate with Owner to schedule the pull in and termination of the fiber cable. Power should be in place at that time. (Fiber for the process control network is required to allow metering of utilities prior to turn on.)

D. Cooling System
   1. Pumps, heat exchangers, piping, control valves, chilled water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, cooling system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.

E. Air Handlers
   1. Prior to owner commissioning, at a minimum, the following items shall be complete: Power wiring, motor rotation check, fire/smoke dampers open, control wiring including all safeties, IO cabinet, air handler cleaned, and filters installed as required. To protect the systems from dirt, outside air with no return will be used until the building is clean enough for return air operation.

F. Some balance work can be done alongside the control work as long as areas are mostly complete and all diffusers are in place.

3.04 FIELD QUALITY CONTROL:
   A. Start-Up: The start-up, testing, and adjusting of digital control systems will be conducted by owner. Once all items are completed by the Contractor for each system, Contractor shall allow time in the construction schedule for owner to complete commissioning of controls before project substantial completion. This task should be included in the original schedule and updated to include the allotted time necessary to complete it. As a minimum, the following items are required to be completed by the Contractor for Owner to begin controls commissioning.

3.05 CLOSEOUT PROCEDURES
   A. Contractor shall provide complete diagrams of the control system including flow diagrams with each control device labeled, a diagram showing the termination connections, and an explanation of the control sequence. The diagram and sequence shall be framed and protected by glass and mounted next to controller.

END OF SECTION 23 09 00
SECTION 23 09 40 – COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 PURPOSE

A. The purpose of commissioning (Cx) the mechanical systems is to verify that the installed systems comply with the intent of the contract documents and to verify that interactions between systems and subsystems operate as intended.

B. The Owner’s personnel will participate in the systems tests to provide them with an opportunity to become familiar with the various systems as they are placed in service. This participation is intended to enhance their training and provide an opportunity for them to work side by side with the Commissioning Agent (CxA), Engineer of Record and the Contractors to gain a better understanding of the design intent.

C. This specification standardizes and organizes reporting to assure that all tests are documented and that reports are received.

D. Any delays in completing the tests shall be the responsibility of the contractor(s) causing the delay.

1.2 TYPE OF TESTING

A. Two (2) types of testing shall be performed:

1. Pre-functional Checklist are tests that will be performed under this Contract as the work progresses by the mechanical contractor with participation by the local code officials.

2. Functional Tests are tests that will be performed prior to substantial completion during a Systems Commissioning Demonstration by a team consisting of the contractors and Owner’s representatives and the Engineer.

1.3 SCOPE OF WORK

A. This section specifies the requirements for the mechanical systems commissioning to be performed. Requirements include setting pressure regulators in piping systems, start up and operation of equipment, the functional testing of HVAC controls, and reporting test results.

B. The following mechanical systems shall be tested per the attached Pre-functional Checklist and Functional Tests.

1.4 CxA RESPONSIBILITIES

A. Issue copies or samples of test forms for equipment used on the project to the General Contractor.

B. Mechanical Systems Cx and Testing Meeting

1. Prepare an agenda for the meeting.

2. Attend the meeting and lead the team in testing the systems. Coordinate the requirements of this section with the responsibilities of the Engineer of Record for Division 26.
3. Witness the operational checks.
4. Prepare an attendance sheet for all test participants to sign.
5. Distribute copies of the attendance sheet and all test forms filled out during the meeting to all participants.
6. Resolve issues where tests results are deficient.

C. Final Reports
   1. Assemble copies of all the test reports (Pre-function Checklist and Functional Tests) into binders and distribute.
   2. Both mechanical and electrical tests forms can be assembled into one report.

1.5 MECHANICAL ENGINEER RESPONSIBILITIES

A. Mechanical Systems Cx and Testing Meeting
   1. Attend the meeting and participate in testing the systems designed.
   2. Witness the operational checks.
   3. Help resolve issues where tests results are deficient.

B. Testing Log
   1. Review logs of all tests

1.6 GENERAL CONTRACTOR’S RESPONSIBILITIES

A. General
   1. The General Contractor shall be responsible for assuring that all testing is executed, that all test reports are submitted, and that this work is completed in a timely manner.

B. Mechanical Systems Cx and Testing Meeting
   1. Attend the meeting and participate in the testing.
   2. Schedule the meeting with the CxA, Owner’s Field Engineer, Engineer of Record, TAB Contractor, BAS Contractor and HVAC, plumbing and electrical subcontractors.
   3. Coordinate the activities of all meeting participants.

C. HVAC Controls
   1. Coordinate construction activities to have the systems ready for testing in accordance with the schedule.
   2. Coordinate the activities of TAB Contractor, BAS Contractor and subcontractors to assure that the testing proceeds on schedule and that all testing is complete.

D. Testing Log
   1. General Contractor shall prepare a log of all tests required by this section and shall monitor progress as the project proceeds. The log shall be reviewed at regularly scheduled Project Progress meetings and shall be distributed with minutes of these meetings.
2. The General Contractor shall maintain a file of all completed tests.

1.7 MECHANICAL CONTRACTOR’S RESPONSIBILITIES

A. General

1. The mechanical contractor with the electrical contractor shall put the HVAC equipment into full operation and continue operating the equipment during the testing. Ensure that all systems are operating free of vibration.

2. Notify the CxA, Owner’s Representative, Field Engineer, Engineer and TAB Firm when the systems are ready for testing. The mechanical contractor shall utilize the Pre-functional Checklists to provide the information to the TAB Firm as to what systems are complete and ready for Testing. A sample of these forms is located in the appendix of this specification.

3. The mechanical contractor shall provide and coordinate the services of sub-contractors, suppliers, and personnel as required to correct, repair or replace defective items or conditions found during the system tests.

B. Mechanical Systems Cx and Testing Meeting

1. Attend the meeting and all testing.

2. Make necessary repairs for deficiencies identified during the tests.

C. HVAC Controls

1. Verify that the installation is complete by filling out the Pre-functional Checklist and submitting the results.

2. Repair deficiencies identified by the Pre-functional Checklist.

3. Implement corrective action if required as identified in the Functional Tests as reported by the TAB Contractor.

1.8 TESTING AND BALANCING FIRM’S RESPONSIBILITIES

A. Mechanical Systems Cx and Testing Meeting

1. Attend the meeting and all mechanical testing and the Fire Alarm System testing.

2. Record the test results.

3. Turn over completed forms to the Engineer at the end of the meeting.

B. HVAC Controls

1. Perform the Operational tests and record the results.

2. Report the test results.

3. Discuss deficiencies with the Engineer.

1.9 BAS CONTRACTOR RESPONSIBILITIES

A. Mechanical Systems Cx and Testing Meeting

1. Attend the meeting and all testing.

B. HVAC Controls
1. Assist the TAB Firm in the Checking, Testing, and Adjusting of the Temperature Control System.
2. BAS shall provide the Commissioning Agent (CA) with a listing of all control loops that are to be tested and the functional requirements to be tested. The Commissioning Agent (CA) shall forward it to the TAB Firm no later than the pre-balancing conference.
3. BAS shall provide the TAB firm technical support (technicians and necessary computers) for a complete check of these systems.
4. BAS shall calibrate all applicable control devices.
5. BAS shall perform all testing and verification of sequences of operation for the AHU’s, terminal units, etc.
6. Implement corrective action if required following the TAB Contractor’s testing of the Operational Verification Checklists or the Mechanical Systems Cx and Testing Meeting.

1.10 OWNER’S REPRESENTATIVE RESPONSIBILITIES

A. Mechanical Systems Cx and Testing Meeting

1. Attend the meeting and all testing.

1.11 SCHEDULING

A. HVAC CONTROLS TESTING: Testing of the HVAC Controls will be scheduled at the same time as the final HVAC Testing, Adjusting, and Balancing. The TAB Firm shall coordinate these tests with the Field Engineer, the Mechanical Contractor and the Electrical Contractor. These tests shall be completed prior to the Systems Testing Meeting.

B. MECHANICAL SYSTEM BAS TESTING: Testing of the Mechanical Systems will be scheduled throughout the construction. The Mechanical Contractor shall coordinate these tests with the Field Engineer and the local Building Officials. All forms shall be submitted no later than three (3) weeks prior to the Systems Testing Meeting.

1.12 DEFINITIONS

A. Test: To determine quantitative performance of equipment.

B. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

C. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing. Refer to forms attached to this specification.

D. Engineer - Engineer of record who is responsible for design of Mechanical Systems.

E. Systems Testing: The functional performance testing and operational verification of the mechanical, electrical, and control systems.

F. BAS: Building Automation System.

G. NEBB: National Environmental Balancing Bureau

H. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers
I. NFPA: National Fire Protection Agency

1.13 SUBMITTAGS AND TESTING REPORT PREPARATION

A. Forms:

1. An index of Pre-functional and Functional Checklists are included at the end of this section along with the checklists for the project.

B. Calibration Reports: Submit evidence that all required instrumentation has been calibrated.

C. Submit test reports indicated. The reports shall certify that the systems have been tested in accordance with the referenced standards; are an accurate representation of how the systems have been installed; and are a true representation of how the systems are operating at the completion of the testing procedures. Follow the procedures and format specified below.

1. Functional Tests:

a. Reports: Upon completion of the Systems Testing Meeting, Functional Tests checklists for the systems tested during the Systems Testing Meeting (and for the items tested by the TAB Firm but not tested at the Meeting) will be turned over to the Engineer. Reports may be hand written, but must be complete, accurate and legible. Review by the Engineer shall be completed and comments (punch list items) returned to the general contractor.

b. A written response addressing comments from the Engineer shall be submitted within two (2) weeks after comments are returned from the Engineer. The written response shall be submitted in accordance with the distribution indicated below for draft reports.

2. Installation Tests:

a. The Mechanical contractors shall submit copies of Functional Tests reports to the Field Engineer and the General Contractor on the day the tests are performed. Identify any problems, so that deficiencies can be resolved. As deficiencies are found, verbally report them to the Field Engineer.

b. The General Contractor shall turn over all subcontractor Installation test results to the CxA who will distribute them.

3. Report Format:

a. Contractors shall use approved forms (see above).

b. The CxA shall bind the report forms complete with other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:

   1) Pre-functional Checklist

      a) Mechanical
2) Functional Tests – Mechanical
   a) Inside Cover Sheet
   b) Sign in sheet from Mechanical Systems Testing Meeting
   c) Operational Verification Checklists
   d) Punch list
   e) Contractors’ response
   f) Follow up items

4. Report Contents: Provide the following minimum information, forms and data:
   a. General Information and Summary: Inside cover sheet to identify CxA, General Contractor, Mechanical Contractor, Sheetmetal Contractor (if separate from the Mechanical Contractor), Plumbing Contractor, Sprinkler Contractor, Owner, Architect, Engineer of Record, and Project. Include addresses, contact names and telephone numbers.

5. Distribution of Reports will be via PDF’s electronically.

1.14 QUALITY ASSURANCE
A. Codes and Standards:

1.15 RELATED DOCUMENTS
A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. General requirements for testing agencies are specified in the Division -1 Section Quality Control Services.
C. Division 23
   1. Sections specify materials and installation of mechanical piping systems.
   2. Sections specify pressure testing requirements and procedures.
   3. HVAC Balancing: Procedures for balancing the HVAC systems are specified in Section 23 05 93.

1.16 ACCEPTANCE AND FINAL PAYMENT
A. Acceptance and final payments shall be made in accordance with the General Conditions.
B. Release of retainage will not be made until all required test reports are submitted and approved by the CxA.
PART 2 - PRODUCTS

2.1 INSTRUMENTATION FOR PIPING AND FLOW TESTING

A. The Mechanical Contractor shall provide the following equipment for any piping tests:
   1. Instrumentation used shall be as listed herein or equal approved by the Engineer of Record.
   2. Pressure Gauge: Bourdon tube type with range of 2 to 2½ times the anticipated test pressure. Accuracy 1% of range. Gauge shall comply with ASME B40.1 Grade A.
   3. Manometer: Use an inclined manometer with graduations of .1 inches or less.
   4. Flow Meter. Contractor may use the existing calibrated flow valves in the system to establish flow rates where such valves are installed. Where the flow being measured does not have a flow meter installed, use a pitot tube or ultrasonic meter to establish flow rate.

PART 3 - EXECUTION

3.1 HVAC SYSTEMS PRE-FUNCTIONAL CHECKLISTS

A. HVAC Equipment: The Mechanical Contractor shall fill out the Pre-functional Checklist for the equipment listed in paragraph 1.03 B-1. Submit in accordance with Part 1.

B. All forms shall be submitted no later than three (3) weeks prior to the Systems Testing Meeting.

3.2 MECHANICAL SYSTEMS CX AND TESTING MEETING

A. Prerequisites for the Mechanical Systems Cx and Testing Meeting
   1. The Functional Tests for the systems shall be completed at least three (3) weeks prior to
      the Two Day Systems Testing Meeting.
   2. Planning for this meeting shall occur at the Pre Balance meeting specified in the Testing
      and Balancing specification.
   3. The TAB Contractor shall have filled out the “preliminary” column of the Operational
      Verification Checklists.

B. Test Procedures
   1. Mechanical Systems Cx and Testing Meeting
      a. The systems will be Cx by a team consisting of representatives from the General
         Contractor, Mechanical Contractor, Electrical Contractor, TAB Contractor, BAS,
         Field Engineer, and the Engineer of Record.
      b. The TAB Contractor shall log new data and fill out the “final walkthrough” column of
         Operational Verification Checklists as the team inspects each system. Any
         deficiencies observed during the tests shall be included on the Final Punchlist to
         assure corrective action is taken.
      c. The intent of the meeting is to verify that the Sequence of Operation is being
         followed and to assure that the systems are operating properly. The checklists are
         intended as a guide; other issues or concerns that effect the operation of the
systems should also be addressed by the team and noted on the bottom of the forms if corrective action is needed.

2. Operational Verification Checklists
   a. Sequence of Operation Check: An item-by-item check of the sequence of operation shall be performed.

3. Reports
   a. The CxA shall collect all of the forms filled out during the Mechanical System Testing Meeting and distribute copies to all participants. Within one (1) week following the meeting, the Engineer shall prepare an “operational punchlist” of items needing follow up and forward this to the General Contractor, the Mechanical Contractor and the Electrical Contractor for corrective action.
   b. The General Contractor shall submit a report of the resolution of all corrective measures taken within two (2) weeks of receiving the operational punchlist.
   c. The attendance list, forms filled out during the meeting, checklists filled out by the TAB Firm for the items tested by the TAB Firm but not tested at the Meeting, the Engineer’s operational punchlist and the General Contractor’s report of corrective measures shall be issued by the Engineer in accordance with Part 1 above.
   d. Any outstanding items shall be followed up by the CxA and the Project Manager until they are resolved.

3.3 INDEPENDENT TEST PROCEDURES FOR HVAC CONTROLS

A. Prerequisites for testing the HVAC Controls
   1. The Mechanical Contractor shall have competed the installation of the equipment and shall have filled out the Pre-functional Checklist (see attached) to confirm that the installation is complete and that the systems are ready for operational testing. Any deficiencies shall be corrected prior to the TAB Contractor filling out the Operational Verification Checklists.
   2. The Electrical Contractor shall turn on all equipment before the tests begin and turn the equipment off at the end of the tests. Repeat for as many days as the tests require.

B. Responsibilities for testing the HVAC Controls
   1. The TAB Firm shall fill out the preliminary system test column of the Functional Tests (see attached) and discuss any deficiencies with the Engineer of Record prior to the Mechanical Systems Cx and Testing Meeting to confirm that the systems are ready for checking by the CxA, Engineer of Record and the Owner’s representatives.
   2. The TAB representative will turn over the forms used for the preliminary tests to the Engineer at the Mechanical Systems Cx and Testing Meeting; these same forms will be used for the final testing. If all of the checklists have not been completed before the Mechanical Systems Meeting, the CxA will provide copies of checklists for items that still need to be tested (i.e. items that were not checked by the TAB firm and that were not checked during the Mechanical Systems Meeting) to the TAB representative so these
tests can be completed immediately following the Mechanical Systems Cx and Testing Meeting.

C. Test Procedures

1. Operational Verification Checklists

   a. General Procedure: The TAB Contractor shall make observations, adjustments, calibrations, measurements, and tests of the systems and their controls and make any necessary control-system corrections to ensure that the systems function as described in the sequence of operation. Software issues will be identified by the TAB Contractor and referred to BAS for resolution.

   b. BAS Sensor Accuracy Check: An accuracy check of the calibration of each sensing element shall be performed by comparing the BAS readout to the actual value of the variable measured at the sensing element. Digital indicating test instruments shall be used. The test instrument and BAS readings shall be logged. The check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element to BAS readout accuracy is within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced by BAS and the calibration check repeated.

   c. Actuator Range Adjustments: An output signal from the BAS shall be applied to each actuator. The proper operation of the actuators for all dampers and valves shall be visually verified. The signal shall be varied from live zero of 4 ma to 20 ma, and the actuator’s travel verified from zero stroke to full stroke within the signal range. Verify that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. Example: NC actuators are closed at 4 ma and are open at 20 ma. The signal levels that move the controlled device to its extreme positions shall be logged.

   d. Sequence of Operation Check: An item-by-item check of the sequence of operation shall be performed as specified in the Operational Verification Checklist for each system. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the time clock. External input signals may be simulated. Basic control sequences shall be verified, however, complex sequences such as those that initiate the economizer operation of an AHU will be verified by BAS during their check out of the BAS system and by monitoring the system after the store is open.

D. Reports

1. The TAB Firm shall submit the operational verification checklists in accordance with the procedures listed in Part 1 above.

3.4 TRAINING DOCUMENTATION

A. General: Other sections of the Division 23 specification require training of the Owner’s personnel in the operation and maintenance of the mechanical equipment and systems. Some of this training is provided by representatives of the equipment manufacturer; some is provided by the contractor.
B. Documentation Summary: The mechanical contractor shall coordinate and organize all the training required and submit the Pre-functional Checklist documenting that the training was performed and who participated in the training sessions.
INDEX

PRE-FUNCTIONAL CHECKLIST

PC-MA  Plan and Documenting Requirements
PC-MB  Calibration and Leak-by Test Procedures
PC-M1  Building Automation System
PC-M2  Air Handler Unit
PC-M3  Terminal Units
PC-M4  TAB Plan

FUNCTIONAL CHECKLIST

FT-M1  Building Automation System
FT-M2  Cooling Air Handling Unit
FT-M3  Terminal Units
FT-M4  Test and Balance TAB

END OF SECTION 230940
Plan and Documenting Requirements for
Startup and Initial Checkout

Primary Equipment and Tag: ________________________________

Component or Related Equipment Included: ____________________

The purpose of documenting the startup and checkout process is to ensure to the Owner that all recommended startup and initial checkout procedures are completed and that a written record of the work is generated.

PLAN and REQUIRED PROCEDURES:

1. The prefunctional checklists provided by SSC Engineering should be filled out and signed for the above primary and related equipment.

2. The manufacturer recommended field startup and checkout sheets should be fully filled out. These startup and checkout sheets are not attached and should be provided by each division contractor.

3. On the manufacturer field startup and checkout sheets, the recommended ranges for readings taken shall be added to each reading field and an explanation given for any variances.

This list of procedures does not constitute a recommendation of the full installation and startup procedures or release the installer from following all factory recommendations, the specifications, applicable codes and good practice. All stock startup record forms normally generated should be filled out and submitted.

All documentation should be submitted to submittals@sscengineering.com, upon completion and is required prior to the execution of functional testing.
Calibration and Leak-by Test Procedures

All field-installed temperature, relative humidity, CO, CO₂ and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Engineer before-hand. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

All procedures used shall be fully documented on the prefunctional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.

1. Sensor Calibration Methods

All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable, are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.

A. Sensors Without Transmitters--Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (DDC)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in DDC, calibrate or replace sensor.

B. Sensors With Transmitters--Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and DDC control panel. Using manufacturer’s resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the DDC. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (DDC)) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Critical Applications. For critical applications (process, manufacturing, etc.) more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

Tolerances, Standard Applications

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<th>Required Tolerance (+/-)</th>
<th>Sensor</th>
<th>Required Tolerance (+/-)</th>
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<td>Barometric pressure</td>
<td>0.1 in. of Hg</td>
</tr>
</tbody>
</table>
2. Valve and Damper Stroke Setup and Check

A. DDC Readout. For all valve and damper actuator positions checked, verify the actual position against the DDC readout.

Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn’t reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

B. Closure for cooling coil valves (NC): Set cooling setpoint 20°F above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20°F below room temperature. Observe valve open. For pneumatics, by override in the DDC, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

3. Coil Valve Leak Check

A. Method 1--Water Temperature With 2-Way Valve. Calibrate water temperature sensors on each side of coil to be within 0.2°F of each other. Turn off air handler fans, close OSA dampers; keep pump running. Make sure appropriate coil dampers are open. Normally closed valves will close. Override normally open valves to the closed position. After 10 minutes observe water delta T across coil. If it is greater than 2°F, leakage is probably occurring. Reset valve stroke to close tighter. Repeat test until compliance.

B. Method 2--Air Temperature With 2-Way Valve. Calibrate air temperature sensors on each side of coil to be within 0.2°F of each other. Change mixed or discharge air setpoint, override values or bleed or squeeze bulb pneumatic controller to cause the valve to close. Air handler fans should be on. After 5 minutes observe air delta T across coil. If it is greater than 1°F, leakage is probably occurring. Reset valve stroke to close tighter. Repeat test until compliance. Water leak-by less than 10% will likely not be detected with this method.

4. Isolation Valve or System Valve Leak Check (for valves not by coils)

A. Method 1--Ultra-sonic flow meter. With full pressure in the system, command valve closed. Use an ultra-sonic flow meter to detect flow or leakage.

-- END OF PROCEDURES--
# Pre-functional Checklist

**PC-M1 BUILDING AUTOMATION SYSTEM**

**Associated checklists:**
- M2- Air Handler
- M3- Terminal Units
- M4- Test and Balance Plan

Contractor filling out this form: ______________________________

## 1. Submittal / Approvals

**Submittal.** The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed. _____________ List attached.

<table>
<thead>
<tr>
<th>Mechanical Contractor</th>
<th>Date</th>
<th>Controls Contractor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical Contractor</th>
<th>Date</th>
<th>Sheet Metal Contractor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TAB Contractor</th>
<th>Date</th>
<th>General Contractor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pre-functional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

This checklist does not take the place of the manufacturer’s recommended checkout and startup procedures or report.

Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).

If this form is not used for documenting, one of similar rigor shall be used.

Contractors assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.

“Contr.” column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor, ____ = ________________________________.

**Approvals.** This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

<table>
<thead>
<tr>
<th>Commissioning Agent</th>
<th>Date</th>
<th>Owner’s Representative</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Notes:

________________________

________________________
2. **Documentation submitted and approved:**

- manufacturer’s cut sheets
- installation and checkout manual and plan
- full written sequences and list of all control strategies
- written copy of all control parameters, settings
- O&M manual
- performance data
- operating manual
- completed control drawings
- design criteria
- full descriptive points list

*Documentation complete as per contract documents* .................................................. ___ YES   ___ NO

3. **Model verification**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>As Specified</th>
<th>As Submitted</th>
<th>As Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model No.</td>
<td></td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Serial No.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other primary features:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The equipment installed matches the specifications for given trade* ...................... ___ YES   ___ NO

4. **Initial Setup and Checkout**

4.1. **User Terminal Interface and Sub-Panel Checks**

<table>
<thead>
<tr>
<th>Check</th>
<th>Y / N</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>General appearance good, no apparent damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment labels affixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layout and location of control panels matches drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Areas or equipment panels serve clear in control drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wiring labeled inside panels (to controlled components)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled components labeled/tagged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS connection made to labeled terminal(s) as shown on drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shielded wiring used on electronic sensors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110 volt AC power available to panel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psig compressed air available to panel (if applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Battery backup in place and operable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panels properly grounded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental conditions according to manufacturer’s requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date and time correct</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
The above setup and checkout was successfully completed for given trade ............ ___ YES   ___ NO

4.2. Device and Point Checkout

The following procedures are required to be performed and documented for each and every point in the control system. The following procedures are minimum requirements. The control contractor is encouraged to identify better and more comprehensive checkout procedures in their submitted plan. These procedures are not a substitute for the manufacturer’s recommended start-up and checkout procedures, but are to be combined with them, as applicable. The documentation may be provided on the vendor’s stock form, as long as all the information in the sample table below can be clearly documented on the form.

Similar checkout and calibration requirements are found on the equipment prefunctional checklists. Redundant documentation is not required. Cross reference, by name and form number, to other forms that contain documentation left blank on the current form.

Verify points as shown on drawing M.701, see “Sample Form”.

Procedures

1. [Wire] Verify that the wiring is correct to each point.
2. [Actu] If the device is or has an actuator, verify full free movement through its full range.
3. [Addr] Verify that the software address is correct.
4. [Load] For devices with a controller, verify that current software program with proper setpoints has been downloaded.
5. [DevCal] Device stroke/range calibration. This applies to all controlled valves, dampers, fans, pumps, actuators, etc. Simulate maximum and minimum transmitter signal values and verify minimum and maximum controller output values and positively verify each and every control device minimum and maximum stroke and capacity range. Follow procedure 6.2 below.
6. [SensLoc] Verify that all sensor locations are appropriate and away from causes of erratic operation.
7. [SensCal] Sensor calibration. Calibrate or verify calibration of all sensors and thermostats, including temperature, pressure, flow, current, kW, rpm, Hertz, etc. Verify that the sensor readings in the control system are within the sensor accuracies specified in this section, using hand-held or other external measuring instruments. Follow procedure 6.1 below.
8. [OperCk] For controlled devices (dampers, valves, actuators, VAV boxes, etc.), after mechanical equipment control becomes operational, perform an operational test of each control loop. Follow procedure 6.2 below. Operational checks are preparatory to the later functional testing.

Other Abbreviations:
[BAS] ......Building automation system or gage-read value.
[Instru].....Instrument (calibrated) read value.
[Ofset].....Offset programmed into the point to correct the calibration.

Notes:
### Controls Checkout Documentation Table

<table>
<thead>
<tr>
<th>Point ID</th>
<th>Object</th>
<th>Field Device Type</th>
<th>Hardware Checks</th>
<th>SensCal</th>
<th>Final Check</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wire</td>
<td>Actu</td>
<td>Addr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>AI-1</td>
<td>ZN-T (zone T)</td>
<td>PhJack</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>3-2a</td>
<td>RA-DPR (damper)</td>
<td>PNEU</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

*The initial setup and checkout has been successfully completed as described in Section 4.2 and Section 6 and documented on attached forms .............................................................. ___ YES   ___ NO

### 5. Sensor and Actuator Calibration

All field-installed temperature, relative humidity, CO, CO₂ and pressure sensors and gages, and all actuators (dampers and valves) shall be calibrated using the methods and tolerances given in the "Calibration and Leak-by Test Procedures" document. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in a packaged unit at the factory with calibration certification provided need not be field calibrated. All calibrations shall be fully documented, including initial and final readings, offsets etc., on prefunctional checklist or other suitable forms.

-- END OF CHECKLIST --

Notes:
Pre-functional Checklist

PC-M2 AIR HANDLER UNIT, AHU-29 & 30

Components included: ___ supply fans, ___ return and exhaust fans, ___ coils, ___ valves, ___ VFD, ___ dampers

Associated checklists: M1-Building Automation System, M4-Test and Balance Plan

Contractor filling out this form: ________________________________

1. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed. ___ List attached.

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Date</th>
<th>Contractor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Contractor</td>
<td></td>
<td>Controls Contractor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Contractor</td>
<td></td>
<td>Sheet Metal Contractor</td>
<td></td>
</tr>
<tr>
<td>TAB Contractor</td>
<td></td>
<td>General Contractor</td>
<td></td>
</tr>
</tbody>
</table>

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

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Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

<table>
<thead>
<tr>
<th>Commissioning Agent</th>
<th>Date</th>
<th>Owner’s Representative</th>
<th>Date</th>
</tr>
</thead>
</table>

Notes:
2. **Requested documentation submitted**

<table>
<thead>
<tr>
<th>Check</th>
<th>Equipment Tag</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer's cut sheets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance data (fan curves, coil data, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation and startup manual and plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sequences and control strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M manuals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Documentation complete as per contract documents for given trade........___ YES   ___ NO*

3. **Model verification**

1 = as specified, 2 = as submitted, 3 = as installed. Check if Okay. Enter note number if deficient.

<table>
<thead>
<tr>
<th>Equipment Tag</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuf. 1</td>
<td>2</td>
</tr>
<tr>
<td>Model 1</td>
<td>2</td>
</tr>
<tr>
<td>Serial # 3</td>
<td></td>
</tr>
<tr>
<td>Capacity 1</td>
<td>2</td>
</tr>
<tr>
<td>Volts/phase 1</td>
<td>2</td>
</tr>
</tbody>
</table>

*The equipment installed matches the specifications for given trade ........___ YES   ___ NO*

4. **Installation Checks**

<table>
<thead>
<tr>
<th>Check</th>
<th>Equipment Tag</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet and General Installation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent labels affixed, including for fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casing condition good: no dents, leaks, door gaskets installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access doors close tightly - no leaks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boot between duct and unit tight and in good condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration isolation equipment installed &amp; released from shipping locks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance access acceptable for unit and components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound attenuation installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal insulation properly installed and according to specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrumentation installed according to specification (thermometers, pressure gages, flow meters, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean up of equipment completed per contract documents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filters installed and replacement type and efficiency permanently affixed to housing--construction filters removed</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Valves, Piping and Coils</strong> (see full piping checklists)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
Check if Okay. Enter comment or note number if deficient.

<table>
<thead>
<tr>
<th>Check</th>
<th>Equip Tag-&gt;</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe fittings complete and pipes properly supported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipes properly labeled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipes properly insulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strainers in place and clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping system properly flushed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No leaking apparent around fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All coils are clean and fins are in good condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All condensate drain pans clean and slope to drain, per spec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves properly labeled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves installed in proper direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSAT, MAT, SAT, RAT, chilled water supply sensors properly located</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves properly labeled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves installed in proper direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSAT, MAT, SAT, RAT, chilled water supply sensors properly located</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensors calibrated (See calibration section below)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motors: Premium efficiency verified, if spec’d?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P/T plugs and isolation valves installed per drawings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fans and Belt / Direct Drive**

<table>
<thead>
<tr>
<th>Check</th>
<th>Equip Tag-&gt;</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply fan and motor alignment correct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply fan area clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply fan and motor properly lubricated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filters clean and tight fitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filter pressure differential measuring device installed and functional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Dampers**

<table>
<thead>
<tr>
<th>Check</th>
<th>Equip Tag-&gt;</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoke and fire dampers installed properly per contract docs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All dampers close tightly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All damper linkages have minimum play</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low limit freeze stat sensor located to deal with stratification &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ducts (preliminary check)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duct joint sealant properly installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No apparent severe duct restrictions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning vanes in square elbows as per drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSA intakes located away from pollutant sources &amp; exhaust outlets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch duct control dampers operable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balancing dampers installed as per drawings and TAB’s site visit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Electrical and Controls**

<table>
<thead>
<tr>
<th>Check</th>
<th>Equip Tag-&gt;</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power disconnects in place and labeled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All electric connections tight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper grounding installed for components and unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safeties in place and operable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starter overload breakers installed and correct size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensors calibrated (see below)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
Check if Okay. Enter comment or note number if deficient.

### Control System Interlocks
- Control system interlocks hooked up and functional

### Smoke Detectors
- Smoke detectors in place

### All Control Devices, Pneumatic Tubing and Wiring
- All control devices, pneumatic tubing and wiring complete

### TAB
- Installation of system and balancing devices allowed balancing to be completed following specified NEBB or AABC procedures and contract documents

### Final
- Smoke and fire dampers and unpowered TU’s are open
- Startup report completed with this checklist attached
- Safeties installed and safe operating ranges for this equipment provided to the commissioning agent
- If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils and in any finished areas. Verify moisture migration is not a problem, due to improper pressures between spaces.

**The checklist items of Part 4 are all successfully completed for given trade.**

### Operational Checks
(These augment mfr’s list. This is not the functional performance testing.)

#### Supply Fan
- Check if Okay. Enter comment or note number if deficient.
- Supply fan rotation correct
- Record full load running amps for each fan. \( \text{rated FL amps} \times \text{srvc factor} = \text{Max amps} \). Running less than max?
- Supply fan has no unusual noise or vibration

#### Dampers
- All dampers (OSA, RA, EA, etc.) stroke fully without binding and spans calibrated and BAS reading site verified (follow procedure in Calibration and Leak-by Test Procedures). List dampers checked:

#### Valves
- Valves stroke fully and easily and spanning is calibrated (follow procedure in Calibration and Leak-by Test Procedures). List each actuated valve here when spanned:

#### Leak-by Test Procedures
- Valves verified to not be leaking through coils when closed at normal operating pressure (follow procedure in Calibration and Leak-by Test Procedures).

#### HOA Switch
- The HOA switch properly activates and deactivates the unit

#### Sequences of Operation
- Specified sequences of operation and operating schedules have been implemented with all variations documented

### Documentation
- Specified point-to-point checks have been completed and documentation record submitted for this system

**The checklist items of Part 5 are all successfully completed for given trade.**

### Notes:

---

PC-M2 Air Handler, AHU
6. Sensor and Actuator Calibration

All field-installed temperature, relative humidity, CO, CO₂ and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated using the methods and tolerances given in the Calibration and Leak-by Test Procedures document. All test instruments shall have had a certified calibration within the last 12 months: Y/N_____.

Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

<table>
<thead>
<tr>
<th>Sensor or Actuator &amp; Location</th>
<th>Location OK</th>
<th>1st Gage or BAS Value</th>
<th>Instr. Meas’d Value</th>
<th>Final Gage or BAS Value</th>
<th>Pass Y/N?</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

Gage reading = reading of the permanent gage on the equipment. BAS = building automation system. Instr. = testing instrument. Visual = actual observation. The Contractor’s own sensor check-out sheets may be used in lieu of the above, if the same recording fields are included and the referenced procedures are followed.

All sensors are calibrated within required tolerances ........................................... YES  NO

-- END OF CHECKLIST--
Prefunctional Checklist

PC-M3 - Terminal Units

Associated checklists M1

Contractor filling out this form

1. Submittal
* For the items assigned to the Contractor(s) signing below, the checklist items are complete as marked and ready for functional testing. The checklist items have been checked off only by parties having direct knowledge of the event. *This checklist is submitted for approval for the TU list attached, subject to the attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon deficiency correction. None of the outstanding items preclude safe and reliable functional testing of other TU's.

<table>
<thead>
<tr>
<th>Controls Contractor</th>
<th>Date</th>
<th>Sheet Metal Contractor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Contractor</td>
<td>Date</td>
<td>Mechanical Contractor</td>
<td>Date</td>
</tr>
</tbody>
</table>

2. Requested Documentation Submitted:

<table>
<thead>
<tr>
<th>Document</th>
<th>Y/N</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer's cut sheets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation and checkout manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M manual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Document</th>
<th>Y/N</th>
<th>Contr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed control drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full written sequences of operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All control parameters, deadbands &amp; setpoints</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Documentation complete as per contract documents**............................................................  ____YES   ____NO

3. Checkout Record

Prefunctional checklist items are to be completed on each TU as part of startup & initial checkout, preparatory to functional testing. Further instructions and an explanation of each checklist item, by column number, are found below. See attached sheets for actual checkout record. This checklist does not take the place of the manufacturer’s recommended checkout and startup procedures or report. The installing contractor’s startup and checkout plan shall make reference to incorporating this checklist or have it attached when submitting the plan to the commissioning agent for approval, prior to execution.

Col. #  **CHECKOUT PROCEDURES AND KEY:**  (refers to column number of TU record)

1. Application and installation in conformance with mfr's recommendations and job specs. Specified sound wrapping and joint sealant installed.
2. Any high pressure ducting upstream has been leak and pressure tested, cleaned and approved prior to setting TU.
3. Model and tag checked against plans and equipment list. Tag or mark affixed.
4. Unit secured per manufacturer's recommendations, contract documents and seismic requirements.
5. Unit has sufficient clearance to be serviced.
6. Inlet conditions OK: Smooth, round, straight duct for at least 3 duct diameters when possible and 2 diameters minimum for velocity pressure sensor for flow readings and 3 to 5 diameters for single point electronic sensors, else airflow straighteners, OR per manufacturer's recommendation.
7. All balancing devices have been provided in compliance with the contract documents.
8. Any hot or chilled water piping installation complete with valves tagged. Auto-flow control valves checked to ensure proper model.
9. Controls Hardware Check: a) Wiring checked to each point. b) Software pt. address input into box and checked for all points (zone te pressures for flow calcs, damper position, fan status, supply air temp., valve position, etc.). c) Release actuator clutch and verify free d
10. Controls Software Load. Power up unit and download approved software program.
11 Operational Check.  a) Start air handler fans.  b) Override space temp. to be 55°F to simulate full heating.  Verify that DDC flow sensors read the maximum heating flow and minimum cooling flow for that box per box schedule. Verify proper opening of heating coil valve, if applicable.  c) Override space temp. to be 80°F to simulate full cooling. Verify that DDC flow sensors read the maximum cooling flow and minimum heating flow for that box per box schedule.  Verify by observation, the proper closing of heating coil valve, if applicable. During above sequencing, if box is fan powered, verify no unusual sound or vibration and verify proper fan staging.

12 Sensor Calibrations.  All Sensors:  a) Verify that all sensor locations are appropriate and away from causes of erratic operation.  Verify sensors with shielded cable, are grounded only at one end.  b) For sensor pairs that are used to determine temperature or pressure differences, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure.  Critical applications may be tighter. Sensor Without Transmitters: Make a reading with a calibrated test instrument within 6 inches of the site sensor.  Verify that the sensor reading (via the permanent thermostat, gage or DDC is within 0.5°F for temps and within 3% of design for pressures of the instrument- measured value.  If not, install an offset in the DDC, calibrate or replace sensor.

** Fully document procedures 9-12 on a separate form for each terminal unit.  The form should have a cell to record each check and calibration for each sensor and DDC point, including initial and final values and max and min cfms.  Other data may also be included (in size, k factor, etc.). The above procedures are not a substitute for the manufacturer's recommended start-up and checkout procedures, are to be combined with them , as applicable.

13 All A/E punch list items related to this TU have been corrected.
14 The system has been balanced in accordance with required procedures and the TAB has been approved for the AHU of this TU.
15 Required pipe cleaning to this unit, pipe flushing and pressure testing has been completed successfully.
16 Construction filter has been removed and final filter installed, if applicable.

3. Approvals

This filled-out checklist has been reviewed.  Its completion is approved with the exceptions noted below.

<table>
<thead>
<tr>
<th>Commissioning Agent</th>
<th>Date</th>
<th>Owner's Representative</th>
<th>Date</th>
</tr>
</thead>
</table>
Pre-Functional Checklist

PC-M4 TAB PLAN--REVIEW CHECKLIST

Components included:   X Airside,   X Water Side

Associated Checklists:
M1 - Building Automation System
M2- Air Handler
M3- Terminal Units

Contractor filling out this form _______________________

The purpose of this checklist is to verify that necessary components of the TAB Plan have been included.

1. Submittal / Approvals

Submittal. The TAB Plan has been developed and reviewed against the checklist below.
This plan is submitted for approval, subject to the attached list of outstanding items yet to be completed.

TAB Contractor ___________________________ Date ___________________________ General Contractor ___________________________ Date ___________________________

The TAB Plan checklist does not take the place of the any recommended formats or procedures in standards referenced in the specifications, but is intended to augment them.
Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).

Approvals. This filled-out checklist and the TAB Plan have been reviewed. Their completion is approved with the exceptions noted below.

Commissioning Agent ___________________________ Date ___________________________ Owner’s Representative ___________________________ Date ___________________________

2. TAB Plan Checklist

Check if included in Plan. Enter comment number if deficient.

<table>
<thead>
<tr>
<th>Check</th>
<th>Air Side</th>
<th>Chilled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specified qualifications and certifications of parties performing TAB work submitted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAB contractor has reviewed drawings and walked through the site and verified that there are sufficient balancing dampers and valves, isolation dampers and valves and test ports installed to perform TAB per spec. Any deficiencies in design or installation that will adversely affect or preclude proper TAB have been reported.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior to plan, TAB contractor had planning meeting with controls contractor to discuss using BAS for TAB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:
<table>
<thead>
<tr>
<th>Check</th>
<th>Air Side</th>
<th>Chilled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>All field checkout sheets and logs provided as part of plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final test report sheets to be used provided as part of plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field and final test report sheets list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion of what notations and markings will be made on the duct and piping drawings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and provide a description of specific test procedures, parameters, formulas and test instrument type to be used for the measurements. Sample forms have been included.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detailed step-by-step procedures for TAB work: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, etc. Similar for water side.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood read of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific procedures that will ensure (and which can be verified) that both air and water side are operating at the lowest possible pressures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside air ventilation criteria under all conditions clearly understood by TAB contractor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details of if and how min. outside air cfm will be verified and set and for what level (total bldg, zone, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details of how building static and exhaust fan / relief damper capacity will be checked.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The identification and types of measurement instruments to be used and their most recent calibration date</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed selection points for sound measurements</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Details regarding specified deferred or seasonal TAB work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details of any specified false loading of systems to complete TAB work</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan for formal progress reports (scope and frequency)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan for formal deficiency reports (scope, frequency and distribution)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**The checklist items of Part 2 are all successfully completed.**

-- END OF CHECKLIST--

Comments:
Functional Test

FT – M1 BUILDING AUTOMATION SYSTEM

1. Participants (fill out once, to cover all TAB work)

<table>
<thead>
<tr>
<th>Party</th>
<th>Participation</th>
<th>Party</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Party filling out this form and witnessing testing ______________________________
Dates of tests _______________________________________________________

2. Parties Responsible to Execute Functional Test
   a. Controls contractor: operate the controls to activate the equipment.
   b. CA: to witness, direct and document testing.

3. Integral Components or Related Equipment Being Tested
   a. Building Automation System
   b. All pre-functional checklists of controlled equipment

4. Prerequisites
   a. PC-M1 BUILDING AUTOMATION SYSTEMS
   b. The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing.
   c. The Cx agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.
   d. A significant part of the DDC functional testing requirements is the successful completion of the functional tests of equipment the DDC controls or interlocks with. Uncompleted equipment functional tests or outstanding deficiencies in those tests lend the required DDC functional testing incomplete.
   e. Integral or stand-alone controls are functionally tested with the equipment they are attached to, including any interlocks with other equipment or systems and thus are not covered under the DDC testing requirements, except for any integrated functions or interlocks listed below.
5. Verification Requirements

In addition to the controlled equipment testing, the following tests are required for the DDC, where features have been specified. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in the specifications.

<table>
<thead>
<tr>
<th>Function / Mode</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISC. FUNCTIONS</td>
<td></td>
</tr>
<tr>
<td>1. All specified functions and features are set up, debugged and fully operable</td>
<td>Verbal discussion of features</td>
</tr>
<tr>
<td>2. Power failure and battery backup and power-up restart functions</td>
<td>Demonstration</td>
</tr>
<tr>
<td>3. Specified trending and graphing features demonstration</td>
<td>See equipment trends</td>
</tr>
<tr>
<td>4. Global commands features</td>
<td>Demonstration</td>
</tr>
<tr>
<td>5. Security and access codes</td>
<td>Demonstration</td>
</tr>
<tr>
<td>6. Occupant over-rides (manual, telephone, key, keypad, etc.)</td>
<td>Demonstration</td>
</tr>
<tr>
<td>7. O&amp;M schedules and alarms</td>
<td>Demonstration</td>
</tr>
<tr>
<td>8. Scheduling features fully functional and setup, including holidays</td>
<td>Observation in terminal screens or printouts</td>
</tr>
<tr>
<td>9. Date and time setting in central computer and verify field panels read the same time</td>
<td>Demonstration</td>
</tr>
<tr>
<td>10. Included features not specified to be setup are installed (list)</td>
<td>Demonstration</td>
</tr>
<tr>
<td>11. Occupancy sensors and controls</td>
<td>Demonstration</td>
</tr>
<tr>
<td>12. Demonstrate functionality of field panels using local operator</td>
<td>Demonstration of 100% of panels and 10% of ports</td>
</tr>
<tr>
<td>keypads and local ports (plug-ins) using portable computer/keypad</td>
<td></td>
</tr>
<tr>
<td>13. All graphic screens and value readouts completed</td>
<td>Demonstration</td>
</tr>
<tr>
<td>14. Setpoint changing features and functions</td>
<td>Done during equipment testing</td>
</tr>
<tr>
<td>15. Communications to remote sites</td>
<td>Demonstration</td>
</tr>
<tr>
<td>16. Sensor calibrations</td>
<td>Sampled during equipment tests</td>
</tr>
<tr>
<td>17. “After hours” use tracking and billing</td>
<td></td>
</tr>
<tr>
<td>18. Final as-buils or redlines (per spec) control drawings, final points list, program code, setpoints, schedules, warranties, etc. per specs, submitted for O&amp;Ms</td>
<td>Observation</td>
</tr>
<tr>
<td>19. Verify that points that are monitored only, having no control function, are checked for proper reporting to DDC.</td>
<td>Observation</td>
</tr>
<tr>
<td>INTEGRATED TESTS</td>
<td></td>
</tr>
<tr>
<td>20. Fire alarm interlocks and response</td>
<td>Demonstration</td>
</tr>
<tr>
<td>21. Duty cycling (if specified)</td>
<td>N/A</td>
</tr>
<tr>
<td>22. Demand limiting (including over-ride of limiting)</td>
<td>N/A</td>
</tr>
<tr>
<td>23. Sequential staging ON of equipment</td>
<td>Either</td>
</tr>
<tr>
<td>24. Optimum start-stop functions</td>
<td>N/A</td>
</tr>
<tr>
<td>25. All control strategies and sequences not tested during controlled equipment testing</td>
<td>Either</td>
</tr>
<tr>
<td>26. Other integrated tests specified in the contract documents</td>
<td></td>
</tr>
<tr>
<td>27. Security system interlocks</td>
<td>Demonstration</td>
</tr>
<tr>
<td>28. Fire protection and suppression systems</td>
<td>Demonstration</td>
</tr>
</tbody>
</table>
H. **Special Procedures** (other equipment to test with, etc.; reference to function ID) – None.

6. **Acceptance Criteria** (referenced by function or mode ID)

   All For the conditions, sequences and modes tested, the DDC, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

   -- END OF CHECKLIST --
Functional Test

FT- M2 COOLING AIR HANDLING UNIT AHU-29 &30

1. Participants

<table>
<thead>
<tr>
<th>Party</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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<tr>
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</tr>
</tbody>
</table>

Party filling out this form & witnessing ___________________________ Date of test _________

2. Prerequisite Checklist

a. The following have been started up and startup reports and prefunctional checklists submitted and approved ready for functional testing:
   __ Chilled Water System       __ Connected Terminal Units
   __ Chilled water piping and valves

b. __ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.

   __________________________________________________________________________
   Controls Contractor Signature or Verbal                                      Date

   __ Piping system flushing complete and required reports approved.
   __ Water treatment system complete and operational.
   __ Vibration control report approved (if required).
   __ Test and balance (TAB) completed and approved for the hydronic systems and terminal units connected.
   __ All A/E punchlist items for this equipment corrected.
   __ These functional test procedures reviewed and approved by installing contractor.
   __ Safeties and operating ranges reviewed.
   __ Test requirements and sequences of operation attached.
   __ Schedules and setpoints attached.
   __ False loading equipment, system and procedures ready (boilers, preheat or reheat coils, control loops, over-ride on OSA dampers, etc.)
   __ Have all energy savings control strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.

   __ Control Program Review. Review the software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.

Notes:
3. **Sensor Calibration Checks.** Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional checklisting.

“In calibration” means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements (__________________________). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

<table>
<thead>
<tr>
<th>Sensor &amp; Location</th>
<th>Location OK</th>
<th>1st Gage or BAS Value</th>
<th>Instr. Meas’d Value</th>
<th>Final Gage or BAS Value</th>
<th>Pass Y/N?</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSAT</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Sensor location is appropriate and away from causes of erratic operation.

4. **Device Calibration Checks.** The actuators or devices listed below checked for calibration. This is a spot check on a sample of the calibrations done during prefunctional checklisting and startup.

“In calibration” means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix.

<table>
<thead>
<tr>
<th>Device or Actuator &amp; Location</th>
<th>Procedure / State</th>
<th>1st BAS Value</th>
<th>Site Observation</th>
<th>Final BAS Reading</th>
<th>Pass Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling coil valve (CCV)</td>
<td>1. Intermediate positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>position or command and stroke*</td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Increase pressure (open)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Remove power or air (closed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device or Actuator &amp; Location</td>
<td>Procedure / State</td>
<td>1st BAS Value</td>
<td>Site Observation</td>
<td>Final BAS Reading</td>
<td>Pass Y/N</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Relief damper position **</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed air damper position **</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main OSA damper position **</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. OSA damper position **</td>
<td>1. Closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Full open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Set pumps to normal mode. **Procedure 1.** Command valve to a few intermediate positions. Verify that readings in BAS reasonably correspond to the actual positions. For cooling coil valves (NC): **Procedure 2.** Lower space setpoint to 20°F below space temperature. Verify BAS reading says CCV is 100% open. Visually verify valve is 100% open. Restore to normal. **Procedure 4.** Set space setpoint to 20°F above space temperature. Verify BAS reading says CCV is closed. Visually verify valve is closed. **Procedure 5.** Remove electricity from the valve and verify that the valve stem and actuator position do not change.

**1. Command damper closed and verify that damper is shut and BAS reads shut. 2. Do the same, commanding damper fully open.

5. Verification of Misc. Prefunctional Checks.

Misc. site checks of the prefunctional checklist and startup reports completed successfully. Pass? Y / N _______

General Conditions of Test

Notes:
### 6. Functional Testing Record

<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAN OFF</td>
<td>Standby Check, With Units Commanded off by BAS.</td>
<td>Verify by visual inspection that: Return Air Dampers are Open Outside Air Dampers are Closed Relief Dampers are Closed Cooling Coil Valves on Cooling Coils are Closed</td>
<td>Pass</td>
<td>Y/N</td>
</tr>
<tr>
<td></td>
<td>UNIT STARTUP</td>
<td>With Units Commanded on by BAS</td>
<td>Supply Fan start</td>
<td>Pass</td>
<td>Y/N</td>
</tr>
<tr>
<td></td>
<td>TEMPERATURE CONTROL--ECONOMIZER</td>
<td>1. Utilizing BAS, Record OSA Temp. and OSA Dewpoint. 2. Calculate Enthalpy of OSA. 3. Utilizing Enthalpy calculations, reset DAT setpoint such that Enthalpy of OSA is less than Enthalpy of Supply Air at revised conditions. Outdoor Air Dampers and Return Air Dampers should modulate in sequence to maintain DAT setpoint. Cooling Coil Valves should be closed.</td>
<td></td>
<td>Pass</td>
<td>Y/N</td>
</tr>
<tr>
<td></td>
<td>TEMPERATURE CONTROL--ECONOMIZER</td>
<td>1. Utilizing Enthalpy calculations above, reset DAT setpoint such that the Enthalpy of Supply Air is less than that of OSA. 2. Return to normal operation. Utilizing BAS trend logging capabilities, record OSA temperature, Return Air Temperature, OSA Dewpoint, DAT setpoint and DAT at 15 min intervals for an 8 hr. period. Unit should attempt to utilize economizer cycle when possible for cooling.</td>
<td>OSA Dampers should close, Return Air Dampers should open, Chilled Water Coil Valves should modulate to maintain discharge Temp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SMOKE CONDITIONS</td>
<td>Interfacing with EC, simulate a fire mode with the Fire Alarm System</td>
<td>Verify that AHU System returns to FAN OFF Status., with OSA and Relief Dampers in a Closed Position.</td>
<td>Pass</td>
<td>Y/N</td>
</tr>
<tr>
<td></td>
<td>FREEZE CONDITION</td>
<td>Overwrite Low Limit Detection Thermostat reading to be 38 Deg. F.</td>
<td>Verify that system alarms, fans stop, OSA Dampers close, Relief Dampers Close, and RA dampers open.</td>
<td>Pass</td>
<td>Y/N</td>
</tr>
<tr>
<td></td>
<td>AHU FILTER DROP</td>
<td>Reset the Filter Differential Pressure to exceed the setting recommended by the filter manufacturer.</td>
<td>Verify that the BAS reports an alarm.</td>
<td>Pass</td>
<td>Y/N</td>
</tr>
</tbody>
</table>

**Notes:**

- Interface with EC, simulate a fire mode with the Fire Alarm System.
- Overwrite Low Limit Detection Thermostat reading to be 38 Deg. F.
- Reset the Filter Differential Pressure to exceed the setting recommended by the filter manufacturer.
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID²</th>
<th>Test Procedure³ (including special conditions)</th>
<th>Expected Response⁴</th>
<th>Pass Y/N</th>
<th>Note</th>
</tr>
</thead>
</table>
|        | CHILLED WATER VALVE CLOSING EFFICIENCY | 1. Utilizing BAS, place AHU Units in WARMUP Mode.  
2. Manually close isolation Valve in Chilled Water Supply to AHU Coil.  
3. Place thermometer in Chilled Water Return Piping adjacent to AHU. Record temp. at 1 min. intervals for 15 min.  
4. Manually open isolation Valve in Chilled Water Supply to AHU Coil.  
5. Repeat Step 3.  
6. Graph Results on Temperature-Time Basis. | Chilled Water Return Temp. should approach RAT. If significant divergence is noted, review specified performance requirements of Chilled Water Control Valves. |          |      |
| REVIEW | REVIEW   | Reviw schedules, current setpoints and sequences with M701 | Submit approved differences to be incorporated into as-builts. |          |      |

Record Foot Notes

²Sequences of operation specified in Contract Documents (attached).
³Mode or function ID being tested from testing requirements section of the project Specifications.
⁴Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
⁵Include tolerances for a passing condition.
⁶Record any permanently changed parameter values and submit to Owner.

-- END OF TEST --

Notes:
Functional Test

FT- M3 TERMINAL UNITS (VAV cooling only)
Data Common For All Units

1. Participants (fill out once, to cover all TU’s)

<table>
<thead>
<tr>
<th>Party</th>
<th>Participation</th>
<th>Party</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Party filling out this form and witnessing testing ______________________________
Dates of tests ______________________    Dates of tests ______________________

2. Test Prerequisites (fill out once, to cover all TU’s)

a. The following have been started up and startup reports and prefunctional checklists submitted and approved:
   _ All terminal units, except ______________________________________________________________
   _ All air handlers serving terminal units, except _______________________________________________

b. _ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed. ________________________________      ___________________________

   Controls Contractor Signature or Verbal Date

c. _ Airside test and balance calibration of BAS readings of TU flows complete (system total flow need not be complete).

d. _ All A/E punchlist items for this equipment corrected.

e. _ These functional test procedures reviewed and approved by installing contractor.

f. _ Test requirements and sequences of operation attached.

g. _ Schedules and setpoints attached.

h. _ Have all energy savings control strategies, setpoints and schedules been incorporated that this TU and control system are capable of? If not, list recommendations below.

i. _ The controller & actuator runtime accumulator set to 0 after prefunctional checkout of the entire system.

j. _ Obtain and review the full program of 5% (randomly chosen) of all TU’s of each type (parameters & setpoints, etc.). Examine variances. Clarify as needed, reconcile and document differences with controls contractor. If too many corrections exist with the sample, controls contractor shall recheck all programming.

The terminal unit testing requirements in the specifications call for a random sample of _____% of all TU’s of each type to be tested. Total number to be tested of this type = __________. The specifications also require that if _____% of the sampled TU’s fail in the testing (any No Pass items), then another _____% of the total population must be tested. This applies to the subsections of the test, i.e., if sub-sections fail, only subsections of additional TU’s need to be tested. Record results in the table below.

<table>
<thead>
<tr>
<th>Sub-Section</th>
<th>% Failed of 1st Sample</th>
<th>% Failed of 2nd Sample</th>
<th>Sub-Section</th>
<th>% Failed of 1st Sample</th>
<th>% Failed of 2nd Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Sensor calibration</td>
<td></td>
<td></td>
<td>IV. Programming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II. Actuator calibration</td>
<td></td>
<td></td>
<td>V. Functional tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III. Static inspections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
**Functional Test Record**

**FT-M3 TERMINAL UNIT __________ (VAV cooling only)**

Common values for all terminal units are recorded on the Cover Sheet. The following five pages of procedures are to be filled out for each TU tested.

**Seasonal Testing and General Conditions of Test**

Air handler or rooftop unit and boiler (if applicable) should be running in normal and occupied mode, unless noted. The tests may be performed in any season, if any temperature lockouts can be overridden.

**Testing Procedures and Record**

___ Computer printout or list made and attached of the current TU setpoints and control parameters and schedules, lockouts, etc. of other systems that may be changed to accomodate testing.

**I. Sensor Calibration Checks.** Check the sensors listed below for calibration and adequate location.

“In calibration” means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements (______________). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

<table>
<thead>
<tr>
<th>Sensor &amp; Location</th>
<th>Location OK¹</th>
<th>1st Gage or BAS Value</th>
<th>Instrument Measured Value</th>
<th>Final Gage or BAS Value</th>
<th>Pass Y/N?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space temp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Sensor location is appropriate and away from causes of erratic operation.

**II. Device Calibration Checks.** --Checked in the Functional Testing Section.

<table>
<thead>
<tr>
<th>Proced No. &amp; Spec. Seq. ID¹</th>
<th>Req ID No.²</th>
<th>Test Procedure³ (including special conditions)</th>
<th>Expected and Actual Response⁴ [Write ACTUAL response or finding in brackets or circle]</th>
<th>Pass Y/N &amp; Note #</th>
</tr>
</thead>
</table>

**III. STATIC INSPECTIONS**

1. Verify sufficient clearance around equipment for servicing.

2. Verify installation of specified sound wrapping and joint sealant.

3. Unit secured per spec.

4. Model and tag checked against plans & equipment list. TU tags affixed.

5. Verify that inlet conditions are OK: Smooth, round, straight duct for at least 3 duct diameters when possible and 2 diameters minimum for velocity pressure sensor and 3 to 5 diameters for single point electronic sensors, else airflow straighteners.

6. Auto TU Diagnostics. In the control system diagnostics, check the controller and actuator accumulated run times, the moving avg. flow error and moving avg. space temp. deviation from setpoint. The ratio of actuator to controller runtime should be ideally < 3% & < 5% is acceptable. [______%]. Moving avg. flow error should be < 10% of max. cooling cfm [______%]. The moving avg. space temp. deviation should be < 3F [______F].

**Notes:**
### IV. CONTROL PROGRAMMING.

In the procedures of this section, compare specified written sequences and parameters with that found programmed in the TU or BAS. Variances that, in the CA’s opinion, reduce performance, must be corrected. Variances that make no difference or enhance performance pass. Document all variances.

<table>
<thead>
<tr>
<th>Proced No. &amp; Spec. Seq. ID</th>
<th>Req ID No. 2</th>
<th>Test Procedure 3 (including special conditions)</th>
<th>Expected and Actual Response 4 [Write ACTUAL response or finding in brackets or circle]</th>
<th>Pass Y/N &amp; Note #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Control drawing sequences of operation
   Per spec and detail adequate.

8. Verify that the TU address matches the TU location and ID on the plan drawings and control drawings.
   Address matches.

9. Verify that the TU max and min setpoints in the BAS match (within 10%) the latest plan drawings and balance report (TAB).
   Cooling:
   Drawing max = _____ min = _____
   BAS max = [_____] min = [_____]  
   TAB max = _____ min = _____

10. Verify that BAS TU K factor is within 20% of K on the submitted control drawings, unless explained by TAB.
    Drawing K = _____  
    BAS K = [_____]  TAB K = ______

11. Cooling -- occupied zone temp. setpoint (indicate if a setting was spec’d)
    Spec’d or reasonable value _____  
    Found [______]

12. Duct area (sf)
    From prints _____  Found [_____]

13. Auto-zero function schedule set and enabled.
    Set and enabled.

### V. FUNCTIONAL TESTING.

22. CFM Capacity Test, Cooling. With the duct SP setpoint being met, lower the space temp. setpoint 20°F. Verify in the BAS that the specified max. cfm is achieved (within deadband).
    For TU’s controlled by damper position only, observe that the damper goes to max. as expected.
    Specified max. cooling cfm = ______
    Achieved cfm or position= [______]
    Within deadband? ______

23. -- Return all changed control parameters and conditions to their pre-test values 5
    Check off in program printout when completed

### MONITORING AND TREND LOGGING

Attach representative graphs or columnar data and explanatory analysis to this test report. The data should have time down the left column and four to six columns of parameters to the right. Provide a key to all abbreviations and attach setpoints and schedules for all trended parameters.

1Sequences of operation attached to this test.
2Mode or function ID being tested from testing requirements section of the project Specifications.
3Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
4Include tolerances for a passing condition. Fill-in spaces or lines not in brackets denote sequence parameters still to be specified by the A/E, controls contractor or vendor. Write "Via BAS" for verifications of device position from BAS readout or "Via obs" for actual observation or from test instrument reading.
5Record any permanently changed parameter values and submit changes to Owner.

A SUMMARY OF DEFICIENCIES IDENTIFIED DURING TESTING IS ATTACHED

-- END OF TEST --

Notes:
Functional Test

FT- M4 TEST AND BALANCE (TAB) CHECKOUT

1. Participants (fill out once, to cover all TAB work)
   Party | Participation | Party | Participation
   ------|---------------|------|---------------
   Party filling out this form and witnessing testing ____________________________
   Dates of tests ______________________________

2. TAB Scope
   The scope of the TAB for this project includes:
   - supply and return air handling systems, including __cooling coil capacity verification, __heating coil capacity verification, __heat exchanger efficiency verification, __OSA quantity verification
   - exhaust fan flows for all exhaust fans except _____________________________________________
   - chilled water system TAB, including __chilled water, condenser water and cooling tower flows.
   - heating water TAB
   - laboratory or specialty room balancing
   - fume hood balancing
   - sound level testing in the following areas: _____________________________________________
     __ other: __________________________________________________________________________

3. Test Prerequisites (fill out once, to cover all TAB recheck work)
   a. The following have been started up and startup reports and prefunctional checklists submitted and approved and the TAB work completed for this equipment and draft TAB report submitted:
      __ All air handlers, except ________________________________________________
      __ All terminal units, except ________________________________________________
      __ All exhaust fans
      __ Hot water system
      __ Chilled water system
      __ Other __________________________________________
   b. __ All control system functions for the above applicable systems and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed. Exceptions: ______________________________
   c. __ All A/E punchlist items for this equipment corrected that may affect TAB, except __________________________________________________________________________
   d. __ All deficient items identified during TAB have been addressed and verified to have been corrected, except: __________________________________________________________________________
   e. __ These functional test procedures reviewed and approved by TAB contractor.

Notes:
f. __ Verify that final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked by the TAB Contractor. List devices checked: ________________________________________

_________________________________________________________________________________________________

4. Verification Requirements
From interpreting the TAB testing requirements in the specifications, the verification of the following systems will be required:

Spec Writer: “R” at the beginning of a requirement means generally Recommended. “O” means Optional, and not always necessary. Edit as appropriate. Note: Test procedures (on subsequent pages) have not been written for all the requirements below.

1. (R) The total supply air flow of 100% of the air handlers, which equals 2 units to test.
2. (R) The total return air flow of 100% of the air handlers, which equals 2 units to test.
3. (R) The fan static discharge pressure during full cooling of 100% of the air handlers, which equals 2 units to test.
4. (R) The OSA flow at air handler flows of: ___near minimum, ___intermediate, ___near maximum, for 100% of the air handlers, which equals 2 units to test.
5. (R) The total measured flow for the TU, at near minimum and maximum flows, matches the value shown on the BAS readout. of 100% of each TU type, which equals 1 units to test total.
6. (R) ___ The measured flow of the diffusers and the total maximum and minimum flows of the TU match that of the TAB report for the TU’s verified.
7. (O) The chilled water flow through 100% of the chillers, which equals 2 units to test.
8. (R) ___Verification that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all TUs taking off downstream of the static pressure sensor, the TU on the critical leg has its damper 90% or more open.
9. ___Other:_______________________________________________________________________________

5. Acceptance Criteria
According to the specifications, section __________________:
A failure¹ of more than 10% of the selected items of a given system² shall result in the failure of acceptance of the final TAB report for that system and the TAB contractor shall be responsible to rebalance the system, provide a new system TAB report and repeat random verifications of the new TAB report.

¹Failure of an item is defined as follows:
   For air flow of supply and return: a deviation of more than 10% of instrument reading
   For minimum outside air flow: 20% of instrument reading (30% for reading at intermediate supply flow for or VFD OSA compensation system using linear proportional control)
   For temperatures: a deviation of more than 1 F
   For air and water pressures: a deviation of more than 10% of full scale of test instrument reading
   For sound pressures: a deviation of more than 3 decibels. (Variations in background noise must be considered)

²Examples of a “system” are: the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system. Systems can be defined smaller if inaccuracies in TAB work within the smaller defined system will have little or no impact on connected systems.

Notes:
TAB Functional Test-Record
FT-M4 TAB CHECKOUT

Seasonal Testing and General Conditions of Test
Air handler or rooftop unit and boilers (if applicable) should be running in normal and occupied mode, unless noted. The tests may be performed in any season, if any temperature lockouts can be overridden.

___ TAB is using the same equipment for verification as for the original work. If not, explain.

1. **TU and Diffuser Flow Procedures** (for each terminal box)

   Party filling out this form and witnessing testing _____________________ Date of tests __________

   **Objectives:**
   1) Verify that the total measured flow for the TU, at near or at minimum and maximum flows, matches the value shown on the BAS readout, that is verify calibration of the EMS readout.
   2) Verify that the measured flow of the diffusers and the total maximum and minimum flows of the TU match that of the TAB report.

   **Procedures:**

   Measure the flow of each diffuser at minimum flow (by raising the space temperature setpoint 10F). Repeat for maximum flow (by lowering the space temperature setpoint 10F below the current space temperature). On a copy of the original TAB report along side the original report values, record the flow at each diffuser and the percent difference from the report. Sum for the total box flow and record the percent difference from the report (clearly identify which values are the recheck values). At both the minimum and maximum flows, record the flow shown in the BAS and record the percent difference from the current actual measured flow. Attach the documentation to this form. Record summary data in the table below.

   **2. Summary Record.** Record the results in the table below. Pass means within 10% of TAB report reading.

|-------|--------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------|-----------------------------------|
### 2. Minimum Outside Air Volume Procedures

Party filling out this form and witnessing testing _____________________ Date of tests ________

This test applies for designs where there is a requirement for a constant volume of OSA into the building with VAV, but no requirement for constant OSA volume at the zone level inside the building.

1. Adjust air handler flow to minimum, intermediate, and maximum, by lowering, adjusting and raising the duct static pressure setpoint, after locking out economizer by raising its changeover setpoint or other method.
2. Measure the OSA flow at the intake using the same method as during original balance. Describe measurement method: _____________________________________________________________________  
   _____________________________________________________________________

3. Record the results in the table below.
   Pass means within 20% of TAB report reading for maximum and minimum supply fan flows. Within 30% is acceptable for intermediate reading, if using a OSA compensating routine with a linearly proportional strategy between max. and min. supply fan flows. If compensating routine, list parameters for each AHU in notes below.

<table>
<thead>
<tr>
<th>AHU</th>
<th>Design Min. OSA (cfm)</th>
<th>Min. Supply Fan Flow</th>
<th>Intermediate Supply Fan Flow</th>
<th>Maximum Supply Fan Flow</th>
<th>Return Parameters to Original?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OSA (cfm) TAB Report</td>
<td>OSA (cfm) ReCheck</td>
<td>OSA (cfm) TAB Report</td>
<td>OSA (cfm) ReCheck</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

A SUMMARY OF DEFICIENCIES IDENTIFIED DURING TESTING IS ATTACHED

-- END OF TEST --
SECTION 23 21 13 – HYDRONIC PIPING

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
      1. Chilled-water heating piping.
      2. Condensate Drain Piping

1.03 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Edition):
      1. American Welding Society (AWS):
         a. A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
         b. D1.1/D1.1M - Structural Welding Code - Steel.
      2. ASME International (ASME):
         a. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
         b. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
         d. B18.2.1 - Square and Hex Bolts and Screws - Inch Series.
         e. B31.9 - Building Services Piping.
         f. Boiler and Pressure Vessel Code: Section IV, "Heating Boilers;" Section VIII, "Pressure Vessels," DIVISION 1; Section IX, "Welding and Brazing Qualifications."
      3. ASTM International (ASTM):
         a. B32 - Solder Metal.
         b. B88 - Seamless Copper Water Tube.
         c. B88M - Seamless Copper Water Tube [Metric].
         d. B813 - Liquid and Paste Fluxes for Solder Applications of Copper and copper Alloy Tube.
         e. B828 - Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
      4. Copper Development Association, Inc. (CDA):
      5. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

1.04 DEFINITIONS:
   A. PTFE: Polytetrafluoroethylene.

1.05 PERFORMANCE REQUIREMENTS:
   A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
      1. Chilled-Water Piping: 150 psig at 200°F (93°C).

1.06 SUBMITTALS:
   A. Product Data: For each type of the following:
1. Pressure-seal fittings.
2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
3. Air control devices.
5. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Qualification Data: For Installer.
D. Welding certificates.
E. Field quality control test reports.
F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

G. Maintenance Material Submittals:
1. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup.
2. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.07 QUALITY ASSURANCE:

A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

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

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS:

A. Drawn-Temper Copper Tubing: ASTM B88, Type L (ASTM B88M, Type B).

B. Wrought-Copper Fittings: ASME B16.22.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. S. P. Fittings; a division of Star Pipe Products.
   c. Victaulic Company.

C. Copper or Bronze Pressure-Seal Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Stadler-Viega.
b. Grinnell
c. Owner approved equal

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200 psig (1379 kPa) working-pressure rating at 250ºF (121ºC).
6. Conform to IAPMO PS 117

2.02 JOINING MATERIALS:
A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.03 DIELECTRIC FITTINGS:
A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Jomar International, Ltd.
      d. Matco-Norca, Inc.
      e. McDonald, A. Y. Mfg. Co.
      f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      g. Wilkins; a Zurn company.
   2. Description:
      b. Pressure Rating: 150 psig (1035 kPa).
      c. End Connections: Solder-joint copper alloy and threaded ferrous.
C. Dielectric Nipples:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elster Perfection.
      b. Grinnell Mechanical Products.
      c. Matco-Norca, Inc.
      d. Precision Plumbing Products, Inc.
      e. Victaulic Company.
   2. Description:
      a. Standard: IAPMO PS 66
      b. Electroplated steel nipple, complying with ASTM F1545.
      c. Pressure Rating: 300 psig (2070 kPa) at 225ºF (107ºC) End Connections: Male threaded or grooved.
SECTION 23 21 13 – HYDRONIC PIPING: CONTINUED

d. Lining: Inert and noncorrosive, propylene.

2.04 VALVES:
A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in DIVISION 23, SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING.
B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in DIVISION 23, Section "Instrumentation and Control for HVAC."
C. Bronze, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design, Inc.
   d. Griswold Controls.
   e. Taco.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
8. Handle Style: Lever, with memory stop to retain set position.
10. Maximum Operating Temperature: 250ºF (121ºC).

2.05 AIR CONTROL DEVICES:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.
B. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
C. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. CWP Rating: 150 psig (1035 kPa).
2.06 HYDRONIC PIPING SPECIALTIES:

A. Y-Pattern Strainers:
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50% free area.

B. Stainless-Steel Bellow, Flexible Connectors:
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4 inch (20 mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250ºF (121ºC).

C. Spherical, Rubber, Flexible Connectors:
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250ºF (121ºC).

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS:

A. Chilled-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:
1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

B. Condensate drain Piping, aboveground, NPS2 (DN 50) and smaller, shall be the following:
1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

3.02 VALVE APPLICATIONS:

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

3.03 PIPING INSTALLATIONS:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

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

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Select system components with pressure rating equal to or greater than system operating pressure.
K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
M. Install piping at a uniform grade of 0.2% upward in direction of flow.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves according to Section 23 05 23 - General-Duty Valves for HVAC Piping.
Q. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
S. Identify piping as specified in SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT.

3.04 HANGERS AND SUPPORTS:
A. Hanger, support, and anchor devices are specified in DIVISION 23, SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT. Comply with the following requirements for maximum spacing of supports.
B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 ft. (6 m) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 ft. (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4 (DN 20): Maximum span, 5 ft. (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1 (DN 25): Maximum span, 6 ft. (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1-1/2 (DN 40): Maximum span, 8 ft. (2.4 m); minimum rod size, 3/8 inch (10 mm).
4. NPS 2 (DN 50): Maximum span, 8 ft. (2.4 m); minimum rod size, 3/8 inch (10 mm).
D. Support vertical runs at roof, at each floor, and at 10 ft. (3 m) intervals between floors.
3.05 PIPE JOINT CONSTRUCTION:
A. Join pipe and fittings according to the following requirements and DIVISION 23 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
G. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.06 HYDRONIC SPECIALTIES INSTALLATION:
A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
C. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

3.07 TERMINAL EQUIPMENT CONNECTIONS:
A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
B. Install control valves in accessible locations close to connected equipment.
C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections according to SECTION 23 05 19 - METERS AND GAUGES FOR HVAC PIPING.

3.08 FIELD QUALITY CONTROL:
A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium, unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90% of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 min., examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

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

END OF SECTION 23 21 13
SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Single-wall rectangular ducts and fittings.
      2. Single-wall round and flat-oval ducts and fittings.
      4. Sealants and gaskets.
      5. Hangers and supports.

1.03 RELATED REQUIREMENTS:
   A. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for testing, adjusting, and balancing requirements for metal ducts.
   B. Section 23 33 00 - Air Duct Accessories for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.04 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Edition):
      1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
         a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
      5. ASTM International (ASTM):
         a. ASTM A36/A36M - Specification for Carbon Structural Steel.
         c. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
         d. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
         e. ASTM C920 - Specification for Elastomeric Joint Sealants.
         f. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.
      7. National Air Duct Cleaners Association (NADCA):
SECTION 23 31 13 – METAL DUCTS: continued

a. NADCA ACR - Assessment, Cleaning and Restoration of HVAC Systems.

8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   b. HVAC Duct Construction Standards - Metal and Flexible.

9. Underwriters Laboratories, Inc. (UL):
   a. UL 723 - Test for Surface Burning Characteristics of Building Materials.

1.05 PERFORMANCE/DESIGN CRITERIA:
   A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
   B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
   C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.06 SUBMITTALS:
   A. Product Data: For each type of the following products:
      1. Adhesives.
      2. Sealants and gaskets.
   B. Shop Drawings:
      1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
      2. Factory- and shop-fabricated ducts and fittings.
      3. Duct layout indicating sizes, configuration, and static-pressure classes.
      4. Elevation of top of ducts.
      5. Dimensions of main duct runs from building grid lines.
      6. Fittings.
      7. Reinforcement and spacing.
      8. Seam and joint construction.
      9. Penetrations through fire-rated and other partitions.
      10. Equipment installation based on equipment being used on wProject.
      11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
      12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
   C. Delegated-Design Submittal:
      1. Sheet metal thicknesses.
      2. Joint and seam construction and sealing.
      3. Reinforcement details and spacing.
      4. Materials, fabrication, assembly, and spacing of hangers and supports.
   D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Suspended ceiling components.
SECTION 23 31 13 – METAL DUCTS: continued

2. Structural members to which duct will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Penetrations of smoke barriers and fire-rated construction.
5. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Access panels.
E. Field quality-control reports.

1.07 QUALITY ASSURANCE:
B. Welding Qualifications: Qualify welding procedures, welders, and welding operators according to the following:
C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-Up."
D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4, "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS:
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class, unless otherwise indicated.
B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS:
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class, unless otherwise indicated.
B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS:
A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 SEALANT AND GASKETS:
A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: -40 to +200ºF.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65%.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
4. Solids Content: Minimum 60%.
5. Shore A Hardness: Minimum 60.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.
2. Type: S.
3. Grade: NS.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
2.05 HANGERS AND SUPPORTS:
   A. Hanger Rods for Noncorrosive Environments: Zinc-plated steel rods and nuts.
   B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
   D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
   E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
   F. Zinc-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
   G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
   H. Trapeze and Riser Supports:
      3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION:
   A. Coordinate duct layout and duct accessory arrangement with Drawings. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated, unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
   B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," unless otherwise indicated.
   C. Install ducts with fewest possible joints.
   D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
   E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
   F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
   G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
   H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
   I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
   J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 - AIR DUCT ACCESSORIES for fire and smoke dampers.

3.02 INSTALLATION OF EXPOSED DUCTWORK:
A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING:
A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-inch w.g. (500 Pa): Seal Class A.
   4. Unconditioned Space, Exhaust Ducts: Seal Class C.
   5. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-inch w.g. (500 Pa) and Lower: Seal Class C.

3.04 HANGER AND SUPPORT INSTALLATION:
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick. These fasteners shall not be used to support ductwork larger than 24 inches square.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
D. Hangers Exposed to View: Threaded rod and angle or channel supports.
E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS:
A. Make connections to equipment with flexible connectors complying with Section 23 33 00 - AIR DUCT ACCESSORIES.
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 FIELD QUALITY CONTROL:
A. Perform tests and inspections.
B. Leakage Tests:
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-inch w.g. (750 Pa): Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25% of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days' advance notice for testing.
C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
D. Duct system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

3.07 DUCT CLEANING:
A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Comply with Section 23 33 00 - Air Duct Accessories for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.
C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97% collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   2. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, or duct accessories.
   4. Provide drainage and cleanup for wash-down procedures.
   5. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.08 START UP:
   A. Air Balance: Comply with requirements in Section 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.09 DUCT SCHEDULE:
   A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   B. Supply Ducts:
      1. Ducts Connected to Variable-Air-Volume Air-Handling Units:
         a. Pressure Class: Positive 3-inch w.g. (750 Pa)w.g. .
         b. Minimum SMACNA Seal Class: B.
         c. SMACNA Leakage Class for Rectangular: 3.
         d. SMACNA Leakage Class for Round and Flat Oval: 3.
   C. Return and Outdoor Air Ducts:
      1. Ducts Connected to Air-Handling Units:
      2. Pressure Class: Positive or negative 2-inch w.g. (500 Pa)w.g.
      3. Minimum SMACNA Seal Class: B.
      5. SMACNA Leakage Class for Round and Flat Oval: 6.
PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Manual Volume Dampers
      2. Fire Dampers
      3. Control dampers.
      4. Duct-mounted access doors.
      5. Flexible connectors.

1.03 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Edition):
         a. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating (ANSI).
      2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      4. ASTM International (ASTM):
         a. ASTM A480/A480M - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
         b. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
         d. ASTM B209M-07 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
         e. ASTM B221-07 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      5. NFPA:
         b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
         a. NAIMA AH116 - Fibrous Glass Duct Construction Standards.
      7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
         a. HVAC Duct Construction Standards - Metal and Flexible
      8. Underwriters Laboratories, Inc. (UL):
         a. UL 181 - Factory-Made Air Ducts and Air Connectors.
         b. UL 555 - Fire Dampers

1.04 SUBMITTALS:
A. Product Data: For each type of product.
B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Control-damper installations.
      c. Wiring Diagrams: For power, signal, and control wiring.
C. Source quality-control reports.
D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION:
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS:
A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Exposed-Surface Finish: Mill phosphatized.
B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and exposed ducts.
C. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 MANUAL VOLUME DAMPERS
A. Standard, Steel, Manual Volume Dampers
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Warming and Ventilating; a division of Mestek, Inc.
      b. McGill AirFlow, LLC.
      c. Nailor Industries, Inc.
      d. Pottorff.
      e. Ruskin Company.
SECTION 23 33 00 – AIR DUCT ACCESSORIES: CONTINUED

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Frame: Hat-shaped, 0.094 inch (2.4 mm) thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch (1.62 mm) thick.
7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have
      axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:
1. Size: 0.5-inch (13-mm) diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on
   supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in
   multiple-damper assembly.

C. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch (2.4-mm) thick zinc-
   plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.04 CONTROL DAMPERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the
   following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Arrow United Industries; a division of Mestek, Inc.
   4. McGill AirFlow, LLC.
   5. Nailor Industries, Inc.
   6. Pottorff.
   7. Ruskin Company.
B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and
   air leakage.
C. Frames:
   1. U shaped.
   2. 0.064-inch thick, galvanized sheet steel.
   3. Interlocking, gusseted corners.
D. Blades:
   1. Multiple blade with maximum blade width of 6 inches.
   2. Parallel-blade design.
SECTION 23 33 00 – AIR DUCT ACCESSORIES: CONTINUED

4. 0.064-inch thick single skin.
5. Blade Seal: TPE

E. Blade Axles: 1/2-inch diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From -40 to +180ºF.

F. Bearings:
   1. Molded synthetic.
   2. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

2.05 FIRE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
B. Closing rating in ducts up to 4-inch w.g. (1-kPa) static pressure class and minimum 2,000-fpm (10-m/s) velocity.
C. Fire Rating: 1-1/2 hours
D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch (0.85-mm) thick galvanized steel; with mitered and interlocking corners.
E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.05 (1.3 mm) thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
F. Mounting Orientation: Vertical or horizontal as indicated.
G. Blades: Roll-formed, interlocking, 0.024-inch (0.61-mm) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch (0.85-mm) thick, galvanized-steel blade connectors.
H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
I. Heat-Responsive Device: Replaceable, 165ºF (74ºC) rated, fusible links.

2.06 DUCT-MOUNTED ACCESS DOORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Ductmate Industries, Inc.
   4. McGill AirFlow, LLC.
   5. Nailor Industries, Inc.
   6. Pottorff.
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1- by 1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
SECTION 23 33 00 – AIR DUCT ACCESSORIES: CONTINUED

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   b. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.

2.07 FLEXIBLE CONNECTORS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Ductmate Industries, Inc.
      2. Duro Dyne, Inc.
      3. Elgen Manufacturing.
      4. Ventfabs, Inc.
   B. Materials: Flame-retardant or noncombustible fabrics.
   C. Coatings and Adhesives: Comply with UL 181, Class 1.
   D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5 3/4 inches wide attached to two strips of 2-3/4 inches wide, 0.028 inch thick, galvanized sheet steel or 0.032 inch thick aluminum sheets. Provide metal compatible with connected ducts.
   E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
      1. Minimum Weight: 24 oz./sq. yd.
      2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
      3. Service Temperature: -50 to +250°F.
   F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
      1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
      2. Outdoor Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
      3. Minimum Additional Travel: 50% of the required deflection at rated load.
      4. Lateral Stiffness: More than 80% of rated vertical stiffness.
      5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
      6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
      7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Install duct accessories according to applicable details in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
   B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. At outdoor-air intakes and mixed-air plenums.
   2. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers. Elsewhere as indicated.

F. Install access doors with swing against duct static pressure.

G. Access Door Sizes:
   1. Head and Hand Access: 18 by 10 inches (460 by 250 mm)

H. Install flexible connectors to connect ducts to equipment.

I. Install duct test holes where required for testing and balancing purposes.

J. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL:

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00
PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Shutoff, single-duct air terminal units.

1.03 REFERENCE STANDARDS:
   A. Applicable Standards (Latest Edition):
      1. Air-Conditioning & Refrigeration Institute (ARI):
         a. ARI 880 - Air Terminals.
      2. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
         b. ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI).
         c. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
      4. ASTM International (ASTM):
         b. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
         c. ASTM C1071 - Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
         e. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.
      5. National Electrical Manufacturers Association (NEMA):
         a. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).
      6. NFPA:
      7. Sheet Metal and Air Conditioning Contractors' National Association:
         a. HVAC Duct Construction Standards - Metal and Flexible.
      8. Underwriters Laboratories, Inc. (UL):
         a. UL 181 - Factory-Made Air Ducts and Air Connectors.

1.04 PERFORMANCE REQUIREMENTS:
   A. Refer to Drawings for capacity performance.
   B. Structural Performance: Hangers, supports and restraints shall withstand the effects of gravity, and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
1.05 SUBMITTALS:
A. Action Submittals:
   1. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
      a. Air terminal units.
      b. Liners and adhesives.
      c. Sealants and gaskets.
   2. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
   3. Delegated-Design Submittal:
      a. Materials, fabrication, assembly, and spacing of hangers and supports.
B. Informational Submittals:
   1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
      a. Ceiling suspension assembly members.
      b. Size and location of initial access modules for acoustic tile.
      c. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   2. Field quality control reports.
C. Closeout submittals:
   1. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
      a. Instructions for resetting minimum and maximum air volumes.
      b. Instructions for adjusting software set points.

1.06 QUALITY ASSURANCE:
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.01 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger.
   2. Nailor Industries, Inc.
   4. Titus.
   5. Trane; a business of American Standard Companies.
B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch (0.85-mm) steel or 0.032-inch (0.8-mm) aluminum], single wall.
   1. Casing Lining: Adhesive attached, 1 inch (25 mm) thick, coated, fibrous-glass duct liner complying with ASTM C1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2% of nominal airflow at 3 inch w.g. (750 Pa) inlet static pressure.

   1. Access door interlocked disconnect switch.
   2. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
   3. Nickel chrome 80/20 heating elements.
   4. Airflow switch for proof of airflow.
   5. Fuses in terminal box for overcurrent protection (for coils more than 48 A).

2.02 SOURCE QUALITY CONTROL:
A. Factory Tests: Test assembled air terminal units according to ARI 880.
   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.

PART 3 - EXECUTION

3.01 INSTALLATION:
A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
C. Install wall-mounted thermostats.

3.02 HANGER AND SUPPORT INSTALLATION:
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.

C. Hangers Exposed to view: Threaded rod and angle or channel supports. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.03 CONNECTIONS:
A. Connect ducts to air terminal units according to Section 23 31 13 - Metal Ducts.
B. Make connections to air terminal units with flexible connectors complying with requirements in Section 23 33 00 - Air Duct Accessories.

3.04 IDENTIFICATION:
A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 - Identification for HVAC Piping and Equipment for equipment labels and warning signs and labels.

3.05 FIELD QUALITY CONTROL:
A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections:
1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Air terminal unit will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.06 STARTUP SERVICE:
A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.
3.07 Demonstration:
   A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

End of Section 23 36 00
SECTION 23 73 13 – MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes:
      1. Variable-air-volume, single-zone air-handling units.

1.03 REFERENCES:
   A. Applicable Standards (Latest Edition):
         b. AHRI 430 - Central-Station Air-Handling Units.
         a. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance
            Rating (ANSI).
         b. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
         c. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test
            Data.
         d. AMCA 511 - Certified Ratings Program. Product Rating Manual for Air Control
            Devices
      3. American Bearing Manufacturers Association (ABMA):
         a. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
      4. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
         a. ASHRAE 33 - Methods of Testing Forced Circulation Air Cooling and Air Heating
            Coils.
         b. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning
            Devices Used in General Ventilation for Removing Particulate Matter.
         c. ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for
            Removal Efficiency by Particle Size (ANSI).
         d. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
      6. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating
         Engineering Society of North America (ASHRAE/IESNA):
         a. ASHRAE/IESNA 90.1- Energy Standard for Buildings except Low-Rise
            Residential Buildings (ANSI).
      7. ASTM International (ASTM):
         a. ASTM B88 - Specification for Seamless Copper Water Tube.
         b. ASTM B88M - Specification for Seamless Copper Water Tube [Metric].
      8. National Electrical Manufacturers Association (NEMA):
         a. NEMA MG 1 - Motors and Generators.
      9. NFPA:
      10. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
         a. HVAC Duct Construction Standards.

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NORMAL POWER UPGRADES
11. Underwriters Laboratories, Inc. (UL):

1.04 PERFORMANCE REQUIREMENTS:
   A. Delegated Design: Design vibration isolation using performance requirements and design
      criteria indicated.
   B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding
      133% of internal static pressures indicated, without panel joints exceeding a deflection of 0.005
      inch per inch of panel.
   C. Casing Air Leakage Rate: Overall unit casing shall be designed to meet ASHRAE 90.1 lowest
      class leakage rate.

1.05 ACTION SUBMITTALS:
   A. Product Data: For each air-handling unit indicated.
      1. Unit dimensions and weight.
      2. Cabinet material, metal thickness, finishes, insulation, and accessories.
      3. Fans:
         a. Certified fan-performance curves with system operating conditions indicated.
         b. Certified fan-sound power ratings.
         c. Fan construction and accessories.
         d. Motor ratings, electrical characteristics, and motor accessories.
      4. Certified coil-performance ratings with system operating conditions indicated.
      5. Dampers, including housings, linkages, and operators.

1.06 INFORMATIONAL SUBMITTALS:
   A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following
      items are shown and coordinated with each other, using input from installers of the items
      involved:
      1. Support location, type, and weight.
      2. Field measurements.
   B. Source quality-control reports.
   C. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS:
   A. Operation and Maintenance Data: For air-handling units to include in emergency, operation,
      and maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS:
   A. Furnish extra materials that match products installed and that are packaged with protective
      covering for storage and identified with labels describing contents.
      1. Filters: One set for each air-handling unit.
      2. Gaskets: set for each access door.
      3. Fan Belts: One set for each air-handling unit fan.

1.09 QUALITY ASSURANCE:
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
      by a qualified testing agency, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 05, "Systems and Equipment" and Section 07, "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 06, "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

1.10 COORDINATION:
A. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a member of the United Technologies Corporation Family.
   2. Engineered Air.
   4. Trane; American Standard, Inc.
   5. YORK International Corporation.

2.02 UNIT CASINGS:
A. General Fabrication Requirements for Casings:
   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   2. Casing Joints: Sheet metal screws or pop rivets.
   3. Sealing: Seal all joints with water-resistant sealant.

B. Panel Construction
   1. All unit panels shall be 2-inch solid, double-wall construction to facilitate cleaning of unit interior. All exterior and interior AHU panels will be made of galvanized steel.
   2. Unit panels shall be provided with a mid-span, no through metal, internal thermal break.
   3. The unit floor shall be of sufficient strength to support a 300-lb. load during maintenance activities and shall deflect no more than 0.005 inch per inch of panel span when sitting on a support structure.
   4. Panel insulation shall provide a minimum thermal resistance (R-value) of 13ft2*h*F/Btu throughout the entire unit, except for narrow jambs. Insulation shall completely fill the panel cavities in all directions so that no voids exist and settling of insulation is prevented. Panel assembly shall comply with NFPA90A.
   5. External surface of unit casing shall be prepared and coated with a minimum of 1.5 mil enamel finish or equal.

C. Casing Leakage
   1. The casing air leakage shall not exceed leak class 9(CL =9) per ASHRAE 111 at1.25 times maximum casing static pressure P in inches w.g., up to a maximum of +8 inches w.g. in all positive pressure sections and -8 inches w.g. in all negative pressure sections, where maximum casing leakage (cfm/100ft2 of casing surface area)=CL x P^0.65.
D. Drain Pans
1. Shall be constructed of stainless steel
2. Drain pan shall be designed in accordance with ASHRAE 62.1 and of sufficient size to collect all condensation produced from the coil and sloped in two planes to promote positive drainage and eliminate stagnant water conditions.
3. The outlet shall be at the lowest point on the drain pan.
4. Drain pan threaded connections shall be visible at the exterior of the unit and shall extend a minimum of 2-1/2 inches beyond the base.

E. Access Doors
1. Access doors shall be 2-inch double-wall construction. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively.
2. Surface-mounted handles shall be provided to allow quick access to the interior of the unit. Handle hardware shall be designed to prevent unintended closure. Access doors shall be hinged and removable for quick, easy access. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.
3. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

2.03 FAN, DRIVE, AND MOTOR SECTION:
A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   b. Designed to operate at no more than 70% of first critical speed at top of fan's speed range.
B. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
C. Plenum fan shall be direct-driven.
D. Fan Shaft Bearings:
1. Pre-lubricated and Sealed Ball Bearings: Self-aligning, pillow-block type with a rated life of 200,000 hours according to ABMA 9.
E. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch (25 mm).
F. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
1. Enclosure Type: Totally enclosed, fan cooled.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
5. Mount unit-mounted disconnect switches on exterior of unit.
G. ECM Motors:
1. Motors shall be variable-speed, DC, brushless motors specifically designed for use with three phase, 480 volt, 60 hertz electrical input.
2. Motor shall be complete with and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator.
3. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero rotor losses.
4. Motor shall have built-in soft start and soft speed change ramps. Motor shall be able to be mounted with shaft in horizontal or vertical orientation.
5. Motor shall be permanently lubricated with ball bearings.
6. Motor shall be direct coupled to the blower.
7. Motor shall maintain a minimum of 70% efficiency over its entire operating range.
8. Inductors shall be provided to minimize harmonic distortion and line noise.
9. Provide isolation between fan motor assembly and unit casing to eliminate any vibration from the fan to the terminal unit casing.
10. Provide a motor that is designed to overcome reverse rotation and not affect life expectancy.

2.04 COIL SECTION:

A. General Requirements for Coil Section:
1. Comply with AHRI 410.
2. Hydronic coils have ½-inch ODx0.016-inch-thick round seamless copper tubes mechanically bonded to coil fins. Coil fins are aluminum with full fin collars that provide maximum fin-tube contact and accurate spacing.
3. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
4. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
5. Coils shall not act as structural component of unit.

2.05 AIR FILTRATION SECTION:

A. General Requirements for Air Filtration Section:
1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Disposable Panel Filters:
1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness: 2 inches (50 mm).
3. MERV (ASHRAE 52.2): 8.
4. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

2.06 DAMPERS:

A. General Requirements for Dampers: Leakage rate, according to AMCA 511, shall not exceed 3 cfm/ft² at in-inch w.g. and 8 cfm/ft² at four-inches w.g.
B. Damper Operators: Comply with requirements in Section 23 09 00 - Instrumentation and Control for HVAC.

2.07 **LAMPS AND FIXTURES**

A. UV-C lamps and fixtures shall be positioned to provide an equal distribution of UV-C energy and to minimize shadowed areas. The fixture assembly shall be designed and installed such that the sum of the lamp arc lengths in a row is a minimum of 90% of the irradiated surfaces total width. the lamps shall not produce ozone.

B. Each lamp shall be high-output, hot cathode, t8 diameter, medium bi-pin type that produces uvgi of 254 nanometers. lamps shall contain no more than 5.5 milligrams of mercury while producing the specified uv-c output when installed in an environment with 500 fpm air velocity and subjected to temperatures of 55-135 degrees f. lamp life shall be 9,000 hours minimum with no more than a 20 percent loss of output after two years of continuous use.

C. The UV-C fixtures and lamps shall be coupled end-to-end and mounted on a slide-out rack to enable complete replacement and/or maintenance of the bulbs from the unit exterior.

D. Fixtures shall meet the ul drip-proof design criteria and be constructed of stainless steel to resist corrosion. racks for fixtures shall be constructed of galvanized steel as ahu interior. fixtures shall have been independently tested and recognized by ul/c-ul under category code abqk (accessories, air duct mounted), ul standards 153, 1598 and 1995.

E. Protection of polymeric materials

   1. All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be tested and certified as uv-c tolerant. any polymeric material in direct or indirect contact with uv-c light not certified as uv-c tolerant shall be completely shielded from the UV-C light using a certified uv-c tolerant material such as metal. UV-C tolerance is defined as being capable of performing its intended duty for a minimum of 20 years.

F. Safety:

   1. Access doors shall be provided at the location of each uv-c light. All sections of the air handler with access doors where the uv-c lights may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door is opened.

   2. In addition to the mechanical interlock switch, each unit shall be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the UV-C lights. the switch shall be equipped with a lock-out/tag-out to prevent unwanted operation of the UV-C lights.

   3. A view port with cover shall be provided in each uv section to allow viewing of the UV-C light array confirming operation. the view port and other ahu windows shall be treated to assure the uv-c energy emitted through it is below the threshold limits specified by NIOSH and ACGIH.

   4. Units shall have a safety warning label applied to the exterior of each section containing UV-C lights.

   5. Complete safety, maintenance and servicing instructions for the UV-C lights and fixtures shall be incorporated into the air handler manufacturers standard installation, operating and maintenance manuals.
2.08 SOURCE QUALITY CONTROL:
A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
C. Water Coils: Factory tested to 300 psig (2070 kPa) according to AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers.
B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.03 CONNECTIONS:
A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to air-handling unit to allow service and maintenance.
C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
D. Connect condensate drain pans using ASTM B88, Type M (ASTM B88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
E. Chilled-Water Piping: Comply with applicable requirements in Section 23 21 13 - Hydronic Piping. Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 - Air Duct Accessories.

3.04 FIELD QUALITY CONTROL:
A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections:
1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safety equipment. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
D. Prepare test and inspection reports.

3.05 STARTUP SERVICE:
A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices, and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.06 ADJUSTING:
A. Adjust damper linkages for proper damper operation.
B. Comply with requirements in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for air-handling system testing, adjusting, and balancing.

3.07 CLEANING:
A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.
3.08 **DEMONSTRATION:**
   A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13
SECTION 260510 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. This Section specifies general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in DIVISION 01:
   1. Submittals.
   2. Coordination drawings.
   3. Record documents.
   5. Rough-ins.
   6. Electrical installations.
   7. Cutting and patching.
   8. Electrical Demolition
   9. Touch-up Painting.
   10. Electrical service and distribution system switch-over.

1.02 RELATED REQUIREMENTS:

A. SECTION 09 90 00 – PROTECTIVE COATINGS for surface coatings.
B. SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT for factory-installed motors, controllers, accessories, and connections.

1.03 REFERENCE STANDARDS:

C. Underwriters Laboratories (UL).
D. Federal Information Processing Standards Publication (FIPS).
E. National Electrical Contractors Association (NECA): National Electrical Installation Standards (NEIS): Except where the NEIS requirements specifically deviate from specific requirements of the NEC, the NEC shall take precedence.

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 01.
B. Refer to each Section of this Division for specific Submittal requirements.
C. Provide Conforming to Construction Records schematic diagrams and wiring diagrams.
D. Provide product data on electrical material and products.

1.05 COORDINATION DRAWINGS:

A. Prepare coordination drawings in accordance with DIVISION 01, for equipment rooms, and other congested areas to a scale of 1/4 inch = 1 foot-0 inch or larger if required. Detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Drawings shall be prepared on 30 by 42 inch sheets. Indicate locations where space is limited for installation and access and where
sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
1. Indicate the proposed locations of major raceway systems, equipment, and materials.
2. Exterior wall and foundation penetrations.
3. Fire-rated wall and floor penetrations.
4. Equipment connections and support details.
5. Sizes and location of required concrete pads and bases.
7. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
8. Prepare floor plans, elevations, and appropriate details to indicate penetrations in floors, walls, and ceilings, and their relationship to other penetrations and installations.
9. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets, air inlets, light fixtures, communications systems' components, sprinklers, heat detectors, smoke detectors, motion detectors, speakers, and other ceiling-mounted devices.
10. Coordinate chases, slots, inserts, sleeves, and openings with general construction work.

1.06 RECORD DOCUMENTS:
A. Prepare record documents in accordance with the requirements specified in DIVISION 01, indicate installed conditions for:
1. Major raceway systems, size and location for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; fuse sizes, circuit breaker sizes and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.07 MAINTENANCE MANUALS:
A. Prepare maintenance manuals in accordance with the requirements specified in DIVISION 01, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data, tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; lockout/tagout procedures; and summer and winter operating instructions.
3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, reassembly; aligning and adjusting instructions.
4. Servicing instructions, lubrication charts and schedules.
5. "Conforming to Construction Records" schematic and wiring diagrams.

1.08 DELIVERY, STORAGE, AND HANDLING:
A. Deliver products to the project site properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
1.09 **WARRANTY:**

A. Provide a minimum one-year warranty on all electrical equipment. Warranty period shall begin at date of Substantial Completion. Contractor shall provide written notification to Owner prior to this warranty start date.

**PART 2 - PRODUCTS**

2.01 **PRODUCTS:**

A. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the requirements of Underwriters Laboratories, Inc. (UL). Where UL requirements are not applicable, equipment and material shall be identified as such by Contractor and approved by Owner before purchase and installation.

2.02 **ELECTRONIC EQUIPMENT COMPLIANCE:**

A. Contractor warrants that all equipment, devices, items, systems, software, hardware, or firmware provided shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents which might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

2.03 **FINISHES:**

A. For equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized surfaces: Zinc-rich paint recommended by item manufacturer.

**PART 3 - EXECUTION**

3.01 **ELECTRICAL SERVICE AND DISTRIBUTION SYSTEM SWITCHOVER:**

A. Maintain all existing systems including electrical service, generators, feeders, chillers, air handlers and boilers for all occupied areas and operational facilities, unless otherwise indicated or when authorized otherwise in writing by Owner. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages to existing systems in accordance with the requirements for Interruption of Existing Electrical Service.

B. **Interruption of Existing Electric Service:** Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than ten business days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Owner's approval of a written outage plan, Method of Procedure, specific for the work being performed during the planned interruption of service.

3. Do not proceed with interruption of electric service without Owner's written permission to proceed.

C. Contractor shall not operate any energized medium voltage equipment.
3.02 ERECTION, INSTALLATION, APPLICATION:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. All electrical work and material shall comply with the following requirements:

1. NFPA 70 - The National Electrical Code (NEC).
3. NECA National Electrical Installation Standards (NEIS) (all except Table 1 of NECA 1).
4. Coordinate electrical systems, equipment, and materials installation with other building components. Equipment motor horsepower sizes and kilowatt sizes shown are approximate. If equipment of a different size is furnished by Contractor, Contractor shall furnish and install the proper support equipment, motor starter, switchgear, feeders, fuses, circuit breaker, disconnect switch, wire, and conduit required for the equipment furnished, at no additional cost to Owner.

5. Verify all existing dimensions by field measurements.
6. Arrange for chases, slots, and openings in other building components during progress of construction to allow for electrical installations.

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

8. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building. Coordinate concrete pads, bases, and related items.

9. Coordinate with all other building trades.

10. Where mounting heights are not specifically detailed, specified, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

11. Coordinate connection of electrical systems with exterior utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

12. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Should coordination requirements conflict with individual system requirements, refer conflict to Owner's Representative in writing.

13. Install systems, materials, and equipment level, plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

14. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.

15. Install access panel or doors where units are concealed behind finished surfaces. The electrical contractor shall be responsible for furnishing access panels required for electrical equipment access. Access panels shall be installed by Contractor.

16. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

17. All equipment and materials shall be installed in accordance with NFPA 70 - The National Electrical Code (NEC).

18. All equipment conductor termination provisions shall be UL listed for 75ºC conductors.

19. All electrical equipment and installations shall be of adequate strength to withstand, without failure, forces encountered in defined Seismic conditions.
20. Install raceways, cables, wireways, cable trays and busways clear of obstructions and clear of the required working space of equipment.

C. Refer to each SECTION of this DIVISION for specific performance requirements.

3.03 DEMOLITION:

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2-inches below surface of adjacent construction. Cap raceways and patch surface to match existing surface finish.

D. Remove demolished material from project site.

E. Remove, store, clean, re-install, reconnect and make operational components indicated for relocation.

F. Disposal of existing fluorescent lamps shall be by Contractor shipping the lamps to an EPA approved recycler for recycling. All shipping and disposal costs will be paid by Contractor at no additional expense to Owner.

3.04 CUTTING AND PATCHING:

A. General: Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of the trades involved. The following requirements apply:

1. Perform cutting and patching for electrical equipment and materials required to:
   a. Uncover work to provide for installation of ill-timed work.
   b. Remove and replace defective work.
   c. Remove and replace work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from Engineer, uncover and restore work to provide for Engineer's observation of concealed work if installed without using the proper specified procedures.

B. For work in existing installations, the Contractor shall cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new work.

C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas per Owner's infection control guidelines and procedures.

E. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

F. All penetrations through fire-rated walls, ceilings and floors shall be sealed with a U.L. listed and FM Global approved sealant system that matches the fire rating of the surface penetrated.

G. Patch existing finished surfaces and building components that must be cut for the electrical installation or are damaged by Contractor using new materials matching existing materials.
H. Patch finished surfaces and building components using new materials specified for the original installation.
I. All cutting, patching, and repairing shall be subject to the supervision and the approval of Owner's Representative.
J. Repair and re-finish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fire proofing where existing fireproofing has been disturbed. Repair and re-finish materials and other surfaces by skilled mechanics of trades involved.

3.05 FINISHES:

A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit degree of damage at each location.
B. Follow paint manufacturer’s written instructions for surface preparation and for timing and application of successive coats.
C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
D. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
E. Repair damage to protective coatings in accordance with manufacturer’s recommendations.

3.06 CLEANING:

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

3.07 PROTECTION:

A. Protect equipment and installations and maintain conditions to ensure that coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

3.08 CLOSEOUT:

A. Instructions, training, and manufacturer’s service representative:
1. Provide on-site instructions and training of Owner's personnel as specified.
2. Provide on-site services of a manufacturer's authorized service representative as specified
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTION, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION includes the following:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600V and less.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 05 13 – MEDIUM VOLTAGE CABLES for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2,001 to 35,000V.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (latest edition):
   1. ASTM International:
      a. ASTM B 3-13 – Specification for Soft or Annealed Copper Wire.
      a. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Sub "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."
   3. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   5. National Electrical Manufacturers Association/Insulated Cable Engineers Association, Inc. (NEMA/ICEA):
      a. NEMA WC 70/ICEA S-95-658 - Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy (ANSI)
   7. Underwriters Laboratories Inc. (UL):
      a. UL 44 - Thermoset-Insulated Wires and Cables.
      b. UL 83 - Thermoplastic-Insulated Wires and Cables.
      c. UL 486A-486B - Wire Connectors.
      d. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables.
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:

continued

1.05 DEFINITIONS:

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.06 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Field quality-control test reports.

1.07 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Wire and Cable, Inc.
   2. Cerro Wire, LLC.; a Marmo Wire & Cable/ Berkshire Hathaway company.
   3. Encore Wire and Cable.
   4. General Cable Corporation.
   5. Senator Wire & Cable Company.; a subsidiary of Southwire Company.
   7. United Copper Industries.
B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Types THHN-THWN, XHHW.

2.02 CONNECTORS AND SPLICES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Cooper Bussmann; Eaton.
   4. O-Z/Gedney; EGS Electrical Group LLC.
   5. 3M; Electrical Products Division.
   6. Tyco Electronics Corp.
   7. ILSCO.
   8. Ideal Industries, Inc.
   10. Thomas & Betts.
   11. Littelfuse.
B. Description: Long barrel compression splices, factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
CONDUCTOR MATERIAL APPLICATIONS:

A. General: Provide wire and cable suitable for the location where installed.
B. Conductors: Minimum conductor size shall be #12 AWG.
C. Insulation Rating: Minimum insulation rating shall be 90°C.
D. Feeders:
   1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
E. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS:

A. Exposed Feeders: Type THHN-THWN or XHHW, single conductors in raceway.
B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN or XHHW, single conductors in raceway.
   1. Multiconductor cable shall only be used for Phase 1 temporary feeder splices.
C. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN or XHHW, single conductors in raceway.
D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.
E. Class 1 Control Circuit: Type THHN-THWN, in raceway.
F. Class 2 Control Circuit: Type THHN-THWN, in raceway.

INSTALLATION OF CONDUCTORS AND CABLES:

A. General: Install electrical cables, wires, and connectors in compliance with NEC.
B. Coordinate cable installation with other work.
C. Do not pull wire and cable until raceway system is complete. Pull conductors simultaneously where more than one is being installed in the same raceway.
D. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
F. Use pulling means, including fish-tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
H. Support cables according to SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
I. Identify and color-code conductors and cables according to SECTION 260553 - ELECTRICAL IDENTIFICATION.
   1. Insulation Color Coding for Phase Identification:
   2. Color code 600V insulated, feeder and branch circuit conductors with factory-applied colored insulation as follows:

<table>
<thead>
<tr>
<th>208Y/120V</th>
<th>480Y/277V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>Red</td>
<td>Orange</td>
</tr>
</tbody>
</table>
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:
continued

Blue  C  Yellow  
White  Neutral  Gray or White  
Green  Ground  Green

J. For multi-wire branch circuits installed in a common raceway provide neutral insulation color noted above with tracer color corresponding to the phase the load is connected to.
K. Keep conductor splices to a minimum. All splices shall be made in junction boxes.
L. Provide adequate length of conductors within electrical enclosures and neatly train the conductors to terminal points. Circuits with conductors larger than No. 10 AWG shall be bundled together inside of enclosures. Make terminations so there are no bare conductors visible at the terminal.
M. Group circuits in conduit such that no conduit contains more than a total of three phase conductors, three neutral conductors, and one ground conductor (unless indicated or specified otherwise).
N. Provide a dedicated neutral conductor for each branch circuit. Sharing of neutrals is not acceptable.
O. Install wire and cable numbers on all field wiring that matches electrical schematics.
P. Wire phasing shall be A, B, C with Phase A connected to the left or top terminal, Phase B connected to the center terminal, and Phase C connected to the right or bottom terminal.
Q. All wire and cable shall be installed in raceways.

3.04 CONNECTIONS:
A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated.
1. Conductor splices and taps for No. 10 AWG and smaller shall be twist-on spring solderless connectors or crimp pressure type connectors. Provide silicone filled twist-on watertight/raintight connectors for all circuits routed outdoors or indoors in wet locations.
2. Taps and bus bar terminations of conductors No. 8 AWG and larger shall be made with compression, crimp type connection devices.
3. Conductor splices No. 8 AWG and larger:
   a. Finger safe power distribution blocks with short circuit and ampacity ratings appropriate for conductor being spliced.
   b. Compression, crimp type two-way splice connector barrel for use with tool and die. Die code shall be embossed on connector after crimping.
4. All uninsulated joints shall be taped to provide an insulation value equal to that of the wire.
B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
C. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:
A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in SECTION 260533 - RACEWAYS FOR ELECTRICAL SYSTEMS.
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: continued

3.06 FIRESTOPPING:

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to SECTION 078413 - PENETRATION FIRESTOPPING.

3.07 FIELD QUALITY CONTROL:

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
   2. Prior to energizing, check all installed feeders and building service wires and cables with insulation megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Record and submit all field test data. Megger 300V cables with 500Vdc megohm meter between each conductor and ground. Megger 600V cables with 1,000Vdc megger between each conductor and ground. Also, megger between adjacent conductors. Megger cables after installation (not on cable reel) with cables disconnected at both ends. Where existing feeders are extended to new electrical equipment, test new conductors prior to splicing to existing conductors. The values must be approximately as follows:

<table>
<thead>
<tr>
<th>Conductor Size (AWG or MCM)</th>
<th>Resistance (Megohms-1,000 ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-8</td>
<td>200</td>
</tr>
<tr>
<td>6-2/0</td>
<td>100</td>
</tr>
<tr>
<td>3/0-500</td>
<td>50</td>
</tr>
</tbody>
</table>

   3. Do not test wires or cables with an ac test set.
   5. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each termination and splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so terminations and splices are accessible to portable scanner.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      b. Record of Infrared Scanning: Prepare a certified report that identifies terminations and splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units, conductors, or cables and retest as specified above.

END OF SECTION 260519
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SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. This Section specifies electrical grounding and bonding as indicated on Drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Type of electrical grounding and bonding work specified in this Section includes the following:
   1. Solidly grounded. Grounded through a ground connection in which no impedance has been intentionally inserted.

C. Applications of electrical grounding and bonding work in this Section include the following:
   1. Electrical power systems.
   2. Grounding electrodes.
   3. Separately derived systems.
   4. Raceways.
   5. Service equipment.
   7. Equipment.
   8. Lighting standards and poles.

D. Refer to other DIVISION 26 Sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this Section.

1.03 REFERENCES:

A. Applicable Standards:
   1. Institute of Electrical and Electronic Engineers (IEEE): Comply with applicable requirements and recommended installation practices of the following IEEE Standards pertaining to grounding and bonding of systems, circuits, and equipment:
      a. 32 - Requirements, Terminology, and Test procedures for Neutral Grounding Devices.
      d. 141 - Recommended Practice for Electric Power Distribution for Industrial Plants.
      e. 142 - Recommended Practice for Grounding Industrial and Commercial Power Systems.
   2. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits, and equipment.
   3. Underwriters Laboratories (UL): Comply with applicable requirements of the following standards. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
      a. 467 - Electrical Grounding and Bonding Equipment.
b. 486A-486B - Wire Connector.
c. 869 - Electrical Service Equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide grounding and bonding products of one of the following (for each type of product):
   1. Grounding Products:
      a. Adalet-PLM Div; Scott Fetzer Co.
      b. Anderson/Square D.
      c. Burndy Corporation.
      d. Cadweld Div; Erico Products Inc.
      e. Crouse-Hinds Div; Cooper Industries.
      f. Ideal Industries, Inc.
      g. Joslyn Corporation.
      h. Myers Electric Products, Inc.
      i. O. Z. Gedney Div; General Signal Corp.
      j. Thomas and Betts Corp.

2.02 GROUNDING AND BONDING:
A. Materials and Components:
   1. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Contractor's code-compliance option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications.
   2. Conductors: Unless otherwise indicated, provide insulated electrical grounding conductors for equipment grounding conductor connections that match power supply wiring materials and as a minimum are sized according to the NEC. Provide uninsulated, stranded, tinned, copper cable for ground electrode conductors.
   3. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required or indicated.

PART 3 - EXECUTION

3.01 APPLICATIONS:
A. Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements.
B. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
EQUIPMENT GROUNDING:

A. Install insulated equipment grounding conductors with all feeders and branch circuits.
B. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug on switchgear, switchboard, or panelboard ground bus. When conduit enters from below and is not connected to the enclosure, ground equipment grounding conductor on conduit grounding bushing and then bond to ground bus (or grounded enclosure if there is no ground bus).
C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway and power cords runs.
   8. Ground wireway at least once and at 10-foot intervals.

INSTALLATION:

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
C. Ground electrical service system neutral at service entrance equipment to grounding electrodes.
D. Ground each separately derived system neutral to:
   1. Main building ground system.
E. Bond the system neutral to service entrance equipment enclosures.
F. Ground all exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground conductors, and metallic plumbing systems.
G. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A-486B to assure permanent and effective grounding.
H. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

LABELING:

A. Comply with requirements in SECTION 260553 – ELECTRICAL IDENTIFICATION for instruction signs. The label or its text shall be green.

FIELD QUALITY CONTROL:

A. Perform tests and inspections.
SECTION 260526 – GROUNDING: continued

B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer’s written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   C. Grounding system will be considered defective if it does not pass tests and inspections.
   D. Prepare test and inspection reports.
   E. Report measured ground resistances that exceed the following values:
      1. 5 ohms.
   F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION specifies hangers, supports, and anchors, for electrical equipment and systems as well as construction requirements for concrete bases specified in other DIVISION 26 SECTIONS.

B. Types of hangers, supports, anchors, sleeves, and seals specified in this SECTION include the following:

1. Clevis hangers.
2. Riser clamps.
3. Steel rod coupling.
4. C-clamps.
5. I-beam clamps.
6. One-hole conduit straps.
7. Two-hole conduit straps.
8. Hexagonal nuts.
9. Round threaded steel rods.
10. Conduit clamps.
11. U-bolts.
12. Toggle bolts.
13. Conduit cable supports.
14. U-channel strut system.
15. Fire and smoke stop compounds.

1.03 RELATED REQUIREMENTS:

A. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other DIVISION 26 SECTIONS.

B. SECTION 260526 - GROUNDING.

C. SECTION 260548.16 – SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.

1.04 REFERENCE STANDARDS:

A. Applicable Standards: Comply with the following standards.

1. ASTM International:
   a. A 36/A 36M-04: Carbon Structural Steel.
   e. D 635-10: Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
2. Manufacturers Standardization Society of The Valve Fitting Industry Inc.
3. National Electrical Contractors Association
   a. 1: Standard Practices for Good Workmanship in Electrical Construction
   b. 101: Standard for Installing Steel Conduits (Rigid, IMC, EMT)
   a. 70 - National Electrical Code (NEC).
5. National Electrical Contractors Association (NECA):
   a. Standard of Installation - Pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
6. Underwriters Laboratories (UL):
   a. Provide electrical devices, components, and fire stops which are UL-listed and labeled.

1.05 PERFORMANCE/DESIGN CRITERIA:

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.06 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

1.07 COORDINATION:

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Anchor Manufacturers: Subject to compliance with requirements, provide anchors of one of the following manufacturers.
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Empire Industries, Inc.
   3. Hilti, Inc.
   4. Unistrut; Atkore International.
B. Channel System Manufacturers: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
1. Allied Tube & Conduit Corp.
2. Eaton/Cooper; B-Line Systems, Industries.
3. Erico International Corp.
4. Kindorf; Thomas & Betts Corp.
5. Power-Strut; Power Engineering Co.
6. Unistrut; Atkore International.

C. Fire and Smoke Stop Compounds: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
1. 3M Company.
2. Hilti, Inc.

2.02 MATERIALS:

A. General: Provide supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published product information, as required for complete installation, and as herein specified. All supports shall be designed for the support of the maximum number of conduits and their maximum conductor weights for maximum conduit loading. Where more than one type of supporting device meets indicated requirements, selection is Contractor's option. Do not use perforated metal straps for supports.

B. Supports: Supporting devices of types, sizes, and materials indicated, and having the following construction features.
1. Clevis Conduit Hangers: For supporting conduit; galvanized steel; with 3/8-, 1/2-, 5/8- or 3/4-inch rod, size of clevis and rod as required.
2. Riser Clamps: For supporting conduit, galvanized steel, with two bolts and nuts.
3. Steel Rod Couplings: Provide 3/8-, 1/2-, 5/8- or 3/4-inch straight rod couplings, size as required.
4. C-Beam Clamps: Malleable iron, 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required.
5. I-Beam Clamps: Galvanized steel, with 3/8, 1/2-, 5/8-, or 3/4-inch rod, size as required; 3/8-inch horizontal "I" hook safety rod that bolts across the flange, flange width as required.
6. One-Hole Conduit Straps: For supporting conduit; stamped plated steel, size as required.
7. Two-Hole Conduit Straps: For supporting conduit, stamped plated steel, size as required.
10. Conduit Clamps: For supporting conduit; galvanized stamped steel, size as required.
11. U-Bolts: For supporting conduit; galvanized, size as required.

C. Anchors: Anchors of types, sizes and materials as required, with the following construction features.
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A325.
4. Toggle Bolts: Springhead, 3/16 by 4 inch or larger size as required.
D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36 & A36M, steel plates, shapes, and bars; black and galvanized.

F. Steel U-Channel Strut Systems: Unless indicated otherwise, U-channel strut system for supporting electrical equipment, 12-gauge steel hot-dip galvanized after fabrication for wet and outdoor locations, 12-gauge standard green paint finish for dry and indoor locations, of types and sizes indicated; construct with 9/16-inch diameter holes, 8 inch o.c. on top surface, and with the fittings as required which mate and match with U-channel.
   1. Comply with MFMA-4, factory-fabricated components for field assembly.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

G. Fire and Smoke Stop Compounds: Comply with Owner’s firestopping program guidelines and procedures.

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION:

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this SECTION are stricter.

B. Install hangers and anchors as specified, required, indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements.

C. Install hangers, supports, clamps, and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and as required by the NEC or as indicated when less than NEC required spacing.

D. Design trapeze type supports, including fasteners to the structure to carry the following loads:
   1. The greater of the following:
      a. The total calculated load multiplied by a factor of 4.
      b. The total calculated load +200 pounds.

E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
   6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

G. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

H. Repair damage to painted finishes with paint recommended by manufacturer.

I. Install fire and smoke stop compounds at all penetrations of fire rated walls, floors, ceilings and roofs. Install fire and smoke stop compounds in accordance with manufacturer's instructions to provide a fire seal rating equal to or greater than that of the surface penetrated.

J. Zip ties are not allowed and shall not be utilized for the support of metal-clad (MC) cable except where attached to chain supports for pendant mounted light fixture.

3.02 CONCRETE BASES:

A. Provide concrete bases for all floor mounted electrical equipment of dimensions not less than 4 inches larger in both directions than supported unit, minimum of 4 inches high, with 3/4” chamfered edges, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Reinforce concrete base with #4 bars at 18” on center with 1-1/2” clear from top of base.

B. All cement shall be Type I cement and conform to ASTM C150 and have a minimum 28 day compressive strength of 4000-psi with the following requirements:
   1. Maximum slump shall be 4” +/- 1”
   2. Maximum water cement ratio shall be 0.45

C. Aggregates for normal weight concrete shall conform to ASTM C33 “Specification for Concrete Aggregates”. The nominal maximum size of aggregate shall not be more than 3/4”.

D. Horizontal concrete surfaces shall be wood floated to depress coarse aggregate and steel troweled to a smooth finish.

E. Use Hilti Hit-RE 500 adhesive or approved equal for dowelled connections to existing concrete.

F. Install dowel rods to connect concrete bases to concrete floor. Provide #3 bars for dowels and embed into existing slab 3” with standard ACI hook centered in concrete base. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

G. Reinforcing shall be ASTM A615 Grade 60.

H. Contractor shall detail and place all reinforcement in accordance with ACI SP-66 Details and Detailing for Concrete Reinforcement.

I. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   4. Anchor switchgear assemblies to channel-iron floor sills embedded in concrete bases and attach by bolting. Install sills level and grout flush with floor or base. Select sills to suit switchgear assemblies.

3.03 PAINTING:
A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.
SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY:

A. This SECTION specifies the following:
1. Conduit.
2. Wireway.
3. Outlet and device boxes.
4. Weatherproof boxes.
5. Junction boxes.
6. Pull boxes.
7. Fittings.
8. Bushings and ground bushings.
9. Locknuts
11. Supports and accessories.

1.02 RELATED REQUIREMENTS:

A. SECTION 078413 – PENETRATION FIREPROOFING for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
B. SECTION 260526 - GROUNDING.
C. SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
D. SECTION 260553 – ELECTRICAL IDENTIFICATION.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. GRC: Galvanized rigid steel conduit.
D. LFMC: Liquid-tight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.

1.04 REFERENCE STANDARDS:

A. Applicable Standards: Comply with applicable requirements of the following standards:
1. National Electrical Manufacturers Association (NEMA):
   a. FB1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable (ANSI)
   b. FB2 – Selection and Installation Guidelines – Fittings for use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit and Electrical Metallic Tubing).
   c. FB2.20 – Selection and Installation Guidelines for Fittings for use with Flexible electrical Conduit and Cable.
d. RV3 – Application and Installation Guidelines for Flexible and Liquidtight Flexible Metal and Nonmetallic Conduits.
e. OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
f. 250 – Enclosures for Electrical Equipment (1,000V Maximum).

2. National Fire Protection Association (NFPA):
   a. NFPA 70 - National Electrical Code, (NEC). Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

3. Underwriters Laboratories (UL):
   a. Provide all raceways which are UL listed and labeled.
   b. 1 - Flexible Metal Electrical Conduit.
   c. 6 - Rigid Metal Electrical Conduit.
   d. 360 - Liquidtight Flexible Steel Conduit.
   e. 467 – Grounding and Bonding Equipment.
   f. 514A – Metallic Outlet Boxes
   g. 514B - Fittings for Conduit and Outlet Boxes.
   h. 797 - Electrical Metallic Tubing.
   i. 870 - Electrical Wireways, Auxiliary Gutters, and Associated Fittings.
   j. 1773 – Termination Boxes.

1.04 SUBMITTALS:

A. Refer to DIVISION 01 and SECTION 260510 - Basic Electrical Requirements for administrative and procedural requirements for submittals.

B. Submittals shall include, but not be limited to, the following:
   1. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

A. Manufacturer:
   1. Subject to compliance with requirements, provide each type of raceway from one of the following:
      a. Rigid Steel Conduit:
         1) Allied Tube and Conduit.
         2) Triangle PWC Inc.
         3) Wheatland Tube Co.
      b. EMT:
         1) Allied Tube and Conduit.
         2) Triangle PWC Inc.
         3) Wheatland Tube Co.
      c. Flexible Metal Conduit:
         1) Anaconda Metal Hose, Div. of ANAMET, Inc.
         2) Electri-Flex Co.
         3) Steelflex Electro Corp.
      d. Rigid Metal Conduit Fittings:
         1) Appleton Electric Co.
         2) Raco Inc.
         3) Thomas & Betts Corp.
      e. Flexible Metal Conduit Fittings:
1) Appleton Electric Co.
2) Electri-Flex Co.
3) O. Z. Gedney Co.

f. EMT Fittings:
1) Appleton Electric Co.
2) Raco Inc.
3) Thomas & Betts Corp.

g. Wireway:
1) Hoffman Engineering Co.
2) Square D Co.

h. Conduit Bodies:
1) Appleton Electric; Div. of Emerson Electric Co.
2) Arrow-Hart Div; Crouse Hinds Co.
3) Bell Electric Div; Square D Co.
4) Gould, Inc.
6) O.Z./Gedney Div; General Signal Co.
7) Spring City Electrical Mfg. Co.

i. Interior Boxes:
1) Appleton; EGS Electrical Group.
2) Bell; Hubbell, Inc.
3) O.Z./Gedney; EGS Electrical Group.
4) Pass and Seymour; Legrand.
5) Raco; Hubbell, Inc.
6) Steel City; Thomas & Betts Corp.

j. Weatherproof Boxes:
1) Appleton; EGS Electrical Group.
2) Arrow Hart; Eaton
3) Hubbell, Inc.
4) O.Z./Gedney; EGS Electrical Group.
5) Pass and Seymour; Legrand.

k. Junction and Pull Boxes:
1) Appleton; EGS Electrical Group.
2) Arrow Hart; Eaton
3) Bell Electric Div; Square D Co.
6) O.Z./Gedney Div; EGS Electrical Group.

l. Bushings, Grounding Bushings and Locknuts:
1) Appleton Electric; Div. of Emerson Electric Co.
2) Arrow-Hart Div; Crouse Hinds Co.
3) O.Z./Gedney Div; EGS Electrical Group.
4) Raco; Hubbell, Inc.
5) Steel City; Thomas & Betts Corp.

m. Electrical Enclosures:
1) Hoffman; Pentair Equipment Protection.
2) Wiegmann; Hubbell, Inc.
2.02 METAL CONDUIT AND TUBING:

A. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thicknesses) for each service indicated. Where types and grades are not specified or indicated, provide proper selection to fulfill specified requirements, and comply with applicable portions of NEC for raceways. Minimum size shall be 3/4 inch, unless indicated or specified otherwise.
   1. Raceways for the following systems shall be identified with factory applied finish:
      a. Life Safety branch: Red.
      b. Critical branch: Orange.
      c. Equipment branch: Yellow.
      d. Fire Alarm: Red.

B. Rigid Steel Conduit: Rigid steel, zinc coated, threaded type conforming to UL6.
   1. Zinc coating fused to inside and outside walls.

C. Electrical Metallic Tubing (EMT): UL797.

D. Flexible Metal Conduit: UL1. Formed from continuous length of spirally-wound, interlocked zinc-coated strip steel. Minimum size shall be 3/4 inch unless indicated or specified otherwise. Approved as a grounding path for circuits rated 20 amperes or less and in lengths of 6 feet and less.

E. Rigid Metal Conduit Fittings: Threaded cast-malleable iron, galvanized or cadmium plated, conforming to UL514B.
   1. Provide steel fittings for steel conduit.

F. Flexible Metal Conduit Fittings: Threadless hinged clamp type. Provide conduit fittings for use with flexible steel conduit. Fittings shall be approved for grounding per NEC 350-5.
   1. Straight Terminal Connectors: One-piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provide with locknut.
   2. 45° or 90° Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

G. EMT Fittings: Steel compression type.

H. Conduit Bodies: Galvanized cast-metal conduit bodies of types, shapes, and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded conduit entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.

I. Conduit and Tubing Accessories: Provide conduit and tubing accessories of types, sizes, and materials, complying with manufacturer's published product information which mate and match conduit and tubing.

J. Conduit Bushings: Provide insulated throat for all bushings. Grounding bushings shall have an integral copper set-screw type cable grounding lug.

2.03 FABRICATED MATERIALS:

A. Outlet Boxes: Galvanized, coated, flat rolled, sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with conduit knockout openings in bottom and sides. Provide boxes with threaded screw holes for grounding screws, fastening devices, box covers, and for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 2.25 inches, provide larger box if required, specified or indicated otherwise.

B. Device Boxes: Galvanized, coated, flat rolled, sheet-steel gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified,
suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, with conduit knockout openings in bottom and sides, and with threaded screw holes for fastening devices and box covers. Provide corrosion-resistant screws for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 2.25 inches, provide larger box if required, specified or indicated otherwise.

1. Device Box Accessories: Provide as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners (use only in existing walls) which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

C. Weatherproof Boxes: Corrosion-resistant, cast-metal, weatherproof, outlet wiring boxes, of types, shapes, and sizes, including depth of boxes as required with threaded conduit hubs for fastening electrical conduit. Provide cast-metal face plates with spring-hinged, watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Galvanized, code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes, and sizes, to suit each respective location and installation; with welded seams and equipped with manufacturer's standard corrosion resistant steel nuts, bolts, screws and washers.

E. Floor Boxes: Cast-iron, raintight, adjustable floor boxes as indicated, with threaded-conduit-entrance ends and vertical adjusting rings, gaskets, brass floor plates with flush screw-on covers with ground flange and stainless steel cover screws.

1. Floor Boxes Accessories: Flush type, duplex, 2-pole, 3-wire, grounding, 125V, 20 ampere, floor-type receptacles with flanges.

F. Bushings: Provide threaded, nylon insulated metallic bushings. Provide steel bushings for conduit sizes 1.5 inches and smaller. Provide malleable iron bushings for conduit sizes 2 inches and larger.

G. Grounding Bushings: Provided where indicated, specified and required by NEC. Provide threaded, insulated, malleable iron bushing with lay-in screw clamp lug.

H. Locknuts: Provide steel locknuts for conduit sizes 2 inches and smaller. Provide malleable iron for conduit sizes 2.5 inches and larger.

I. Sealing Hub: Provide watertight, threaded, insulated sealing hub connectors for all outdoor and indoor wet locations where conduit enters into enclosures. Sealing hub threaded lengths shall be adequate to allow installation of bushing.

J. Knockout Closures: Provide steel press-in knockout seals for all unused punched out knockouts 2 inches and smaller. Provide steel two-piece bolt on knockout seals for all unused punched out knockouts 2.5 inches and larger.

K. Fittings: Provide all threaded nipples, insulated short elbows, offset nipples, offset connectors, enlargers and reducers as required. Provide EMT compression type connectors with insulated throat. Provide EMT compression type insulated short elbows as required. Provide EMT setscrew type offset connectors as required.

L. Hinged-Cover Enclosures:

1. Comply with UL 50 and NEMA 250, TYPE 1, TYPE 3R with continuous-hinge cover with flush latch unless otherwise indicated.
   a. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   c. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 1, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 INSTALLATION OF RACEWAYS:

A. General:
   1. Install raceways as indicated in accordance with manufacturer’s written installation instructions and in compliance with NEC. Install raceways plumb and level, and maintain NEC recommended clearances. Provide raceway supports in accordance with the NEC and Section 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.

3.02 INSTALLATION OF CONDUITS:

A. General: Install concealed conduits in new construction work - in walls, in slabs, or above suspended ceilings. Run conduits concealed in existing work where practicable. Where conduits cannot be concealed in finished areas, use surface metal raceways only where indicated. Provide holes for conduit in all boxes, panels and enclosures as required.
   1. All conduit installed above grade including exposed and concealed above removable suspended ceilings that contains emergency power and emergency lighting conductors shall be identified in accordance with Section 260553 - Electrical Identification.
   2. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrical conductor. Connect to electrical boxes, fittings, and cabinets to provide electrical continuity and firm mechanical assembly.
   3. Avoid use of dissimilar metals throughout system to eliminate possibility of galvanic corrosion. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
   4. Install miscellaneous fittings such as reducers, close nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install telescoping type linear expansion fittings in raceways every 200 foot linear run and wherever structural expansion joints are crossed.
   5. Use roughing-in dimensions of electrically powered units furnished by unit manufacturer. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.
   6. Test conduits (witnessed by the Owner) required to be installed but left empty with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition. Provide 200 pounds tensile strength nylon conduit fish line throughout the entire length of all empty conduits. Leave 12 inch of slack at each end.
   7. Do not install conduit in front of covers of new and existing electrical equipment, pull boxes, and junction boxes.
   8. Provide all openings in floors, walls, ceilings and roofs for passage of conduit. Fire ratings of walls, floors, ceiling and roofs shall be maintained when passing through them by
providing fire seals in accordance with Section 078413 – PENETRATION FIRESTOPPING.

9. Where different conduits contain circuits of different noise levels the horizontal and vertical spacing in inches between the outside surfaces of the conduits or conduit to cable tray shall not be less than indicated below unless specified otherwise, indicated otherwise, or required otherwise by the equipment manufacturer:
   a. Noise Level 1 Circuits: Analog circuits less than 50V, digital circuits less than 12V or telephone circuits.
   b. Noise Level 2 Circuits: Analog circuits greater than 50V or digital circuits greater than 12V.
   c. Noise Level 3 Circuits: 120Vac or dc circuits operating at less than 20 amperes.
   d. Noise Level 4 Circuits: Ac or dc circuits less than 800V operating with currents less than 800 amperes.
   e. Noise Level 5 Circuits: Circuits over 800Vac or dc and/or over 800 amperes.

MINIMUM HORIZONTAL AND VERTICAL SPACING BETWEEN DIFFERENT CONDUIT OUTSIDE SURFACES
(OR CONDUIT TO CABLE TRAY) IN INCHES

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10. Provide a weatherproof duct seal compound between the conductors and the inner walls of all conduit that are routed to NEMA 3, 3R, 3S, 4 and 4X enclosures to prohibit moisture and/or humid air from entering the raceway and condensing.

11. Repair damage to galvanized finishes with a zinc-rich paint recommended by the manufacturer.

12. Repair damage to PVC finishes with matching touch-up coating recommended by the manufacturer.

13. Where metallic conduit leaves cast-in-place concrete to air, to earth, or to compacted fill coat the conduit 2 inches on either side of the line formed by the finished concrete surface with a bitumastic asphalt coating.

3.03 RACEWAY APPLICATION:

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: RMC.
   2. Concealed Conduit, Aboveground: RMC.
   3. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Raceways for circuits above 600V shall be RMC
   2. Exposed (600V and below): EMT.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Concealed in Existing to Remain Interior Walls and Partitions: EMT
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: RMC.
7. Hazardous storage, flammable storage, and Class 1, Division 2 Electrical Classification areas: RMC.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 in institutional and commercial kitchens and damp or wet locations. Explosion-proof for hazardous locations.

3.04 INSTALLATION:

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
C. Complete raceway installation before starting conductor installation.
D. Comply with requirements in SECTION 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for hangers and supports.
E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
H. Support conduit within 12 inches of enclosures to which attached.
I. Conduit installed above suspended ceilings shall comply with the following:
   1. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts or outlets.
   2. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.
J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
N. Terminate conduits square to enclosures into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install locknuts hand tight plus 1/4 turn more. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
Q. Conduits shall not cross pipe shafts, access openings or ductwork openings.
R. Support riser conduit at each floor level with clamp hangers.
S. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
T. Size conduits as indicated, unless no size is indicated then size per NEC, except no conduit smaller than 3/4 inch shall be embedded in concrete or masonry.
U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
V. Install conduits so as not to damage or run through solid structural members. Avoid horizontal or cross runs in building partitions or side walls.
W. Expansion-Joint Fittings:
   1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100ºF and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125ºF temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155ºF temperature change.
      c. Indoor Spaces Connected with Outdoors without Physical Separation: 125ºF temperature change.
      d. Attics: 135ºF temperature change.
   3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
   4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
   5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed luminaires, the final 24 inches for connection to equipment subject to vibration, noise transmission, or movement; and for transformers and motors in nonhazardous locations. Provide a "green" insulated equipment ground wire suitably sized per NEC 250.122 unless indicated otherwise in all flexible steel conduit.
Y. Provide explosionproof flexible metal conduit where indicated or required.
Z. Concealed Conduits:
   Install underground conduits a minimum of 24 inches below finished grade.
AA. Conduits in Concrete Slabs: Prohibited.
BB. Exposed Conduits:
   1. Install exposed conduits and extensions from concealed conduit systems neatly and parallel with or at right angles to walls of building or structure.
   2. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts or outlets.
   3. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.
   4. Run conduit for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
   5. Above requirements for exposed conduits also apply to conduits installed in space above suspended ceilings and in crawl spaces.
CC. Conduit Fittings:
1. Provide locknuts for securing conduit to metal enclosures with a sharp edge for digging into metal and ridged outside circumference for proper fastening. Standard locknuts are not acceptable.
2. Provide threaded, nylon insulated bushings for terminating conduits which have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
3. Provide threaded, grounding bushings of insulated type with copper set screw clamp type lay-in grounding terminal where required by NEC, where indicated or specified.
4. Provide miscellaneous fittings such as reducers, close nipples, 3 piece unions, split couplings, and plugs as required which are specifically designed for their particular application.
5. Provide grounding in accordance with SECTION 260526 - GROUNDING.
6. Provide raintight hubs on all outdoor conduit that are terminated in an nonthreaded enclosure hole.
7. Provide identification of all raceways as specified in SECTION 260553 - ELECTRICAL IDENTIFICATION.
8. EMT shall have galvanized compression type box connectors at all boxes.

3.05 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:
A. General: Install electrical boxes, bushings, locknuts, nipples, connectors, sealing hubs, and fittings as required, indicated, in accordance with applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
C. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
D. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
E. All boxes containing emergency power and lighting circuits shall be identified as specified in SECTION 260553 – ELECTRICAL IDENTIFICATION.
F. Provide knockout closures to cap unused knockout holes where blanks have been removed.
G. Install electrical boxes in only those locations which ensure ready accessibility to enclosed electrical wiring.
H. Maximum box size in a fire-rated wall shall be 4 inches by 4 inches square. Do not install boxes back-to-back in walls. In nonfire-rated and nonacoustic- rated walls, provide not less than 6 inches horizontal separation between boxes installed in opposite sides of wall. Provide not less than 24 inches horizontal separation between boxes installed in opposite sides of fire-rated and acoustic-rated walls.
I. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
J. Do not install aluminum products in concrete.
K. Position recessed outlet boxes accurately to allow for surface finish thickness.
L. Set floor boxes level and flush with finish flooring material.
M. Fasten electrical boxes firmly and rigidly to the surfaces to which attached, structural surfaces to which attached, or solidly embed them in concrete or masonry. Do not support boxes by conduits.
N. Provide electrical connections for installed boxes.
O. Locate boxes so that cover or plate will not span different building finishes.
P. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Q. Subsequent to installation of boxes, protect boxes from construction debris and damage.

3.06 GROUNDING:

A. Properly ground electrical boxes and demonstrate compliance with NEC requirements. Bond all non-isolated equipment grounding conductors to all electrical boxes.

END OF SECTION 260533
SECTION 260553 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION specifies electrical identification work including the following:
1. Electrical power, control, and communication conductors and raceways.
2. Operational instructions and warnings.
3. Danger, caution and warning signs.
4. Equipment/system identification nameplates.

1.03 REFERENCE STANDARDS:

A. Applicable Standards: Comply with the applicable requirements of the following standards.
1. American National Standards Institute (ANSI):
2. ASME International:
3. Federal Specifications (FS):
   a. FS L-P-387 - Polyethylene Low and Medium Density - Molding Material (for designation plates).
   a. 70 - National Electrical Code (NEC), as applicable to installation of identifying labels and markers for wiring and equipment.
5. Occupational Safety and Health Administration (OSHA):
6. Underwriters Laboratories (UL), pertaining to electrical identification systems:
   a. 969 – Standards for Marking and Labeling Systems.

1.04 SUBMITTALS:

A. Refer to DIVISION 01 and SECTION 260510 - BASIC ELECTRICAL REQUIREMENTS for administrative and procedural requirements for submittals.
B. Includes, but not limited to, the following:
1. Product Data: Submit manufacturer's data on electrical identification materials and products.

1.05 QUALITY ASSURANCE:

B. Comply with NFPA 70.
D. Comply with ANSI Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.06 COORDINATION:

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other SECTIONS requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):
   1. Brady Worldwide, Inc.
   2. Panduit Corp.
   4. Thomas & Betts Corp.

2.02 ELECTRICAL IDENTIFICATION MATERIALS:

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option; but provide single selection for each application.
B. Raceway Identification Materials:
   1. Raceways connected to unit substations, switchgear, automatic transfer switches, and distribution panels:
      a. Self-adhesive vinyl tape marker not less than 3 mils thick. Provide minimum 1-1/8 inch wide by 4-1/2 inch long marker for 2 inch and smaller conduit. Provide minimum 2-1/4 inch wide by 9 inch long marker for 2-1/2 inch and larger conduit.
         1) Provide machine printed black lettering on white field for raceways and cable tray carrying normal power circuit cables and indicate "Normal Power" on label.
         2) Provide machine printed lettering as described above which indicates load and source raceway is connected to.
         3) Identify raceway at source, load, and 50-foot intervals where located in accessible locations.
         4) Normal power example (white field, black lettering):
            NORMAL POWER
            ATS-CH1 FED FROM USS-HNB
2. Labels for branch circuit raceways connected to lighting and appliance panelboards at 600V or less: Permanent, waterproof, machine printed, self-adhesive label with white field and black filled letters. Identify circuit number(s) of conductor(s) contained in the raceway. The use of handheld label makers is acceptable for this application.

C. Conductor Identification Materials:
1. Conductors 600V or less: Provide factory applied, color coded, conductor insulation. Colored, self-adhesive vinyl tape is not acceptable.
2. Wire/Cable Identification Bands:
   a. Vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either prenumbered plastic coated type or machine printed type with clear plastic self-adhesive cover flap; numbered to show circuit identification number indicated on Drawings or Shop Drawings.

D. Plasticized Tags:
1. General: Preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inches by 5-5/8 inches, with brass grommets and wire fasteners, and with appropriate preprinted wording, including large-size primary wording, e.g., "DANGER, DO NOT OPERATE." Tags shall comply with OSHA requirements.

E. Self-Adhesive Plastic Signs:
1. General: Self-adhesive or pressure-sensitive, preprinted, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., "EXHAUST FAN." Colors: Unless otherwise indicated or required by governing regulations, provide white signs with black lettering for equipment connected to normal power. Provide red signs with white lettering for equipment connected to life safety power, critical power, and equipment branch power.

F. Baked Enamel "Danger" Signs:
1. "DANGER" signs of baked enamel finish on 20-gauge steel unless specified otherwise; of standard safety red, safety black, and safety white as defined by ANSI Z535.1; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., "_____VOLTS, KEEP AWAY." Sign shall conform to OSHA and ANSI Z535.1.

G. Baked Enamel "Caution" Signs:
1. "CAUTION" signs of baked enamel finish on 20 gauge steel unless specified otherwise; of standard safety yellow with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., "Caution: Ear Protection Required in this Area."

H. Baked Enamel "WARNING" Signs:
1. "WARNING" signs of baked enamel finish on 20 gauge steel unless specified otherwise; of standard safety orange with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is largest size that can be applied where needed and except where larger size is needed for adequate vision; with recognized standard explanation wording. Sign shall conform to OSHA and ANSI Z535.1.

I. Engraved Plastic-Laminate Nameplates:
1. General: Engraving stock melamine plastic laminate nameplates, in sizes (minimum height of characters shall be 3/16 inch) and thicknesses specified or indicated, engraved with engraver's standard letter style of sizes and wording indicated, white face and black core plies (letter color) for normal power except as otherwise indicated, specified or
required. Nameplate shall be punched for mechanical fastening except where adhesive mounting is necessary because of surface it is mounted to.

a. Thickness: 1/16-inch, for units up to 20 square inches or 8 inch length; 1/8-inch for larger units.

b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate surface it is mounted to.

2. Lettering and Graphics:
   a. Coordinate names, abbreviations, and other designations used in electric identification work with corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION:

A. General Installation Requirements:
   1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.
   2. Coordination: Where identification is to be applied to surfaces which require finish painting, install identification after completion of painting.
   3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit Identification Markers:
   1. General: Where electrical conduit is exposed or installed in accessible locations, apply identification markers on electrical conduit at 50 foot intervals visible from the floor and within 3 feet of all panelboards, switchboards, switchgear, automatic transfer switches, substations, switches, devices, and circuit breakers readily visible when standing in front of equipment.
   2. Medium Voltage raceways shall be identified with color coded label at 25 foot intervals and within 3 feet of all switchgear connections.
   3. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

C. Wire/Cable Identification Bands:
   1. General: Apply cable/conductor identification bands, including circuit number, on each wire/cable in each box/enclosure/cabinet/panelboard where wires of more than one circuit or communication/signal system are present. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

D. Operational Identification and Warning Plasticized Tags and Metal Signs and Plastic Signs:
   1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install signs with instruction or warnings. When signs are installed on switches, outlets, controls, devices and covers of electrical enclosures they may be self-adhesive vinyl or plastic. Where detailed instructions or explanations are
needed, provide plasticized tags with clearly written messages adequate for intended purposes.

E. Danger Signs:
1. General: In addition to installation of danger signs specified, indicated, and required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about Project.
2. XXXX Volts: Install danger signs (with actual circuit voltage) on all building doors, substations, switchgear, switchboards, panelboards switches, circuit breakers, etc., wherever it is possible (under any circumstances) for persons to come into contact with electrical voltages to ground greater than 277V.
3. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons or damage to or loss of property.
4. Provide the following danger sign on the equipment indicated:
   a. "Danger This Machine Starts Automatically" on all pumps, air handlers, fan arrays, exhaust fans, and emergency generators.
5. Provide the following danger signs on the doors leading to the equipment indicated:
   a. "Danger Hearing Protection Required" on all emergency generator room doors.
   b. "Danger: No Smoking, Matches or Open Flames" on all emergency generator room doors and battery room doors.

F. Warning Signs:
1. Provide an orange background sign with black letters reading "WARNING: LOAD SIDE OF SWITCH MAY BE ENERGIZED BY BACKFEED" on all tie switches and tie circuit breakers.

G. Caution Signs:
1. Provide the following yellow background caution sign with black letters on all panelboards, substations, switches, circuit breakers, and switchboards where turning off a circuit will automatically start an emergency generator:
   a. "Caution: Turning Off this Circuit will Automatically Start Emergency Generators".
2. Provide the following yellow background caution sign with black letters on all automatic transfer switches, uninterruptible power systems, switches, circuit breakers, equipment, and emergency panelboards that are energized by the emergency power system:

H. Equipment/System Identification Nameplates:
1. General: Install engraved plastic-laminated nameplates on each major unit of electrical equipment, central or master unit of each electrical system including communication/control/signal/alarm systems in the building as specified in paragraph 2.02, I.
2. Provide text matching terminology and numbering included in the contract documents and shop drawings. Nameplate shall include unit designation, power source circuit number and room number ("Fed from panel name – circuit number; room number"), circuit voltage, and other data specifically indicated on nameplate details included on Drawings. Provide nameplates for each unit of the following categories of electrical work:
   a. Unit substations.
   b. Switchgear.
   c. Switchboards.
   d. Distribution panelboards.
   e. Lighting and appliance panelboards.
   f. Transformers.
   g. Disconnect switches.
h. Variable frequency motor controllers.
i. Motor starters.
j. Contactors.
k. Enclosed switches and circuit breakers.
l. Enclosed controllers.
m. Lighting control equipment, including remote controlled switches and control devices.
n. Uninterruptible power supplies (UPS).
o. Main switches and all circuit breakers located in unit substations, switchgear, switchboards, and distribution panelboards.
p. Electrical cabinets, and enclosures.
q. Access panel/doors to electrical facilities.

3. Install markers, tags, nameplates, and signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure the identification with fasteners, except use adhesive where fasteners should not or cannot penetrate surface.

3.02 IDENTIFICATION SCHEDULE:

A. Exposed or Accessible Raceways, connected to unit substations, switchgear, automatic transfer switches, and distribution panels at 600V or less: Identify with self-adhesive vinyl label as specified in paragraph 2.02, B, 1.

B. Exposed or Accessible Raceways, for branch circuit raceways connected to lighting and appliance panelboards at 600V or less: Identify with self-adhesive vinyl label as specified in paragraph 2.02, B, 2.

C. Exposed or Accessible Raceways and Junction Boxes within Buildings: Identify the covers of each junction and pull box with paint as follows:
   1. Fire Alarm – red.

D. Junction and pull box covers shall include and identify circuit numbers, panelboard designation, system voltage, and service (normal, life safety, critical, or equipment power).

E. Raceways for the following systems shall be identified with color-coded, self-adhesive vinyl tape applied in bands or factory applied finish:
   4. Equipment Branch System: Yellow, factory applied finish.

F. Power-Circuit Conductor Identification, 600 V or Less: For all conductors in pull and junction boxes, manholes, and handholes, use factory applied color-coding to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
      a. Color shall be factory applied.
      b. Colors for 208/120-V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral: White.
         5) Ground: Green.
SECTION 260553 – ELECTRICAL IDENTIFICATION: continued

6) Switch Legs: Pink.
c. Colors for 480/277-V Circuits:
   1) Phase A: Brown.
   2) Phase B: Orange.
   3) Phase C: Yellow.
   4) Neutral: White or Gray.
   5) Ground: Green.
   6) Switch Legs: Purple.

G. Conductors to Be Extended in the Future: Attach write-on tags and/or marker tape to conductors and list source and circuit number.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

END OF SECTION 260553
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. The purpose of this Section is to define Contractor responsibilities in the commissioning process, which are being directed by the Contractor. Other electrical system testing is required under other Division 26 Specification Sections. National Electrical Installation Standards (NEIS) NECA 90-2004, “Recommended Practice for Commissioning Building Electrical Systems”, 27th Volume of the NEIS Series, provides additional guidance for the commissioning of electrical systems.

B. Commissioning requires the participation of the Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 26 shall be familiar with all parts of the Commissioning Plan and shall execute all Commissioning responsibilities assigned to them in the Contract Documents and include the cost of Commissioning in the Contract price.

C. Electrical systems to be commissioned include the following:
   2. Unit Substations.
   3. Distribution and Branch Circuit Panelboards.
   4. Grounding Systems
   5. Medium and Low-Voltage Feeders

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards.

1.04 DEFINITIONS

A. Commissioning: A systematic process confirming that building systems have been installed, properly started, and consistently operated in strict accordance with the Contract Documents, that all systems are complete and functioning in accordance with the Contract Documents at Substantial Completion, and that Contractor has provided Owner adequate system documentation and training.
B. Commissioning Authority (CxA): The Professional, appointed by the Owner, to direct and coordinate the commissioning process.

C. Commissioning Plan: Document that provides the structure, schedule, and coordination plan for the Commissioning process from the construction phase through the warranty period. The Commissioning Plan must satisfy the Owner’s test requirements.

D. Commissioning Team: Working group made up of representative(s) from the Architect/Engineer (AE), the CxA, Contractor, Owner’s Test, Adjust, and Balance (TAB) Firm, Building Automation System (BAS) provider, specialty manufacturers and suppliers, and Owner. Contractor will provide ad-hoc representation of Subcontractors on the Commissioning Team as required for implementation of the Commissioning Plan.

E. Deferred Tests: Functional Performance or Integrated System Tests performed after Substantial Completion due to partial occupancy, partial equipment acceptance, seasonal requirements, design, or other Site conditions that prohibit the test from being performed prior to Substantial Completion.

F. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents.

G. Factory Testing: Testing of equipment at the factory, by factory personnel with an Owner’s representative present if deemed necessary by Owner.

H. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configuration and steps required to determine if the system is performing and functioning properly. Contractor prepares these procedures to document Functional Performance Tests.

I. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems executed by Contractor. Systems are tested under various modes, such as high loads, component failures, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Functional Performance Tests are executed after start-ups and Prefunctional Checklists are complete.

J. Integrated System Test: Test of dynamic function and operation of multiple systems. Integrated System Tests are tested under various modes, such as fire alarm and emergency situations, life safety conditions, power failure, etc. Systems are integrally operated through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Integrated System Tests are executed after Functional Performance Tests are complete and prior to Substantial Completion. Integrated System Tests provide verification that the integrated systems will properly function according to the Contract Documents.

K. Integrated System Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configurations and steps required to determine if the interacting systems are performing and functioning properly. Contractor prepares these procedures to document Integrated System Tests.

L. Prefunctional Checklist: A list of static inspections and material or component tests that verify proper installation of equipment (e.g., labels affixed, sensors/meters calibrated, etc.). The word Prefunctional refers to before Functional tests. Prefunctional Checklists must include the manufacturer’s Start-up checklist(s). Contractor shall sign Prefunctional Checklists as complete and submit with the Request for Start-up/Functional Performance Test Form.

M. Start-up: The activities where equipment is initially energized, tested, and operated. Start-up is completed prior to Functional Performance Tests.
N. Test Requirements: Requirements specifying what systems, modes and functions, etc. must be tested. Test requirements are not detailed test procedures. Test requirements and acceptance criteria are specified in the Contract Documents.

1.05 SUBMITTALS

A. Contractor shall prepare Prefunctional Checklists and Functional Performance Test (FPT) procedures and execute and document results. Refer to Examples in Sections 26 08 13 and 26 08 16. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Commissioning Team for review and approval.

B. Contractor shall provide Owner with documentation required for Commissioning work. At minimum, documentation shall include: Detailed Start-up procedures, Factory Test Reports, Full sequences of operation, Operating and Maintenance data, Performance data, Functional Performance Test Procedures, Control Drawings, and details of Owner-Contracted tests.

C. Contractor shall submit to Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.

D. Contractor shall review and approve other relative documentation for impact on FPT’s of the systems:

1. Shop Drawings and product submittal data related to systems or equipment to be commissioned. The Subcontractor responsible for the FPT shall review and incorporate comments from the Owner and AE via the Contractor.

2. Incorporate manufacturer’s Start-up procedures with Prefunctional checklists.

3. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT’s.

4. Completed equipment Start-up certification forms along with the manufacturer’s field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT’s.

5. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 TEST EQUIPMENT

A. Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.
B. All specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable. Contractor must calibrate test equipment and instruments according to manufacturer’s recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

C. Infrared Thermographic Scanner:

1. Infrared scanning equipment shall be capable of viewing an entire bus or equipment assembly at one time and have a sensitivity of < 50mK.

2. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified.

PART 3 - EXECUTION

3.01 PREPARATION

A. Construction Phase:

1. Include the following requirements for submittal data, Commissioning documentation, testing assistance, Operating and Maintenance (O&M) data, and training, as a minimum.

2. Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings to facilitate the Commissioning process.

3. Provide manufacturer’s data sheets and shop drawing submittals of equipment.

4. Provide additional requested documentation, prior to O&M manual submittals, for development of Prefunctional Checklist and Functional Performance Tests procedures.

   a. Typically, this will include detailed manufacturer’s installation and Start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.

   b. In addition, the installation, Start-up, and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted.

   c. This information and data request may be made prior to normal submittals.

5. With input from the BAS Provider, the Owner and AE, clarify the operation and control of commissioned equipment in areas where the Specifications, BAS control drawings, or equipment documentation are not sufficient for writing detailed test procedures.

6. Develop the Commissioning Plan, in cooperation with the CxA, using manufacturer’s Start-up procedures and the Prefunctional Checklists. Submit manufacturer’s detailed Start-up procedures and the Commissioning Plan and procedures and other requested equipment documentation to Owner for review.

7. Prepare the specific Functional Performance Test procedures specified in Section 26 08 16. Ensure that Functional Performance Test procedures address feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests.
8. During the Start-up and initial checkout process, execute and document related portions of the Prefunctional Checklists for all commissioned equipment.

9. Perform and clearly document all completed Prefunctional Checklists and Start-up procedures. Provide a copy to the Owner prior to the Functional Performance Test.

10. Address current AE and Owner punch list items before Functional Performance Tests.

11. Provide skilled technicians to execute starting of equipment and to assist in execution of Functional Performance Tests. Ensure that they are available and present during the agreed-upon schedules and for a sufficient duration to complete the necessary tests, adjustments, and problem solving.

12. Correct deficiencies (differences between specified and observed performance) as interpreted by the Owner’s Project Manager, the CxA and AE and retest the system and equipment.

13. Compile all Commissioning records and documentation to be included in a Commissioning and Closeout Manual.

14. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

15. During construction, maintain as-built marked-up Drawings and Specifications of all Contract Documents and Contractor-generated coordination Drawings. Update after completion of Commissioning activities (include deferred tests). The as-built drawings and specifications shall be delivered to the Owner both in electronic format and hard copies as required by the Owner.

16. Provide training of the Owner’s operating personnel as specified.

17. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

B. Warranty Phase:

1. Execute seasonal or deferred tests, witnessed by the Owner, according to the Specifications.
   a. Complete deferred tests as part of this Contract during the Warranty Period. Schedule this activity with Owner. Perform tests and document and correct deficiencies. Owner may observe the tests and review and approve test documentation and deficiency corrections.
   b. If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, execution of such test may be delayed to later in the Warranty Period, upon approval of the Owner. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as deferred tests.

2. Correct deficiencies and make necessary adjustments to O&M manuals, Commissioning documentation, and as-built drawings for applicable issues identified in any seasonal testing.

C. Electrical Testing Agency (ETA):

1. The Contractor shall retain an independent Electrical Testing Agency (ETA). This generally requires checking and testing of the electrical power distribution equipment per National Electrical Testing Association (NETA).

2. Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings scheduled by the Contractor to facilitate the Commissioning process.

3. Obtain all required manufacturer’s data to facilitate tests.
4. Aid the Contractor in preparation of the specific Prefunctional Checklist and Functional Performance Test procedures specified in Section 26 08 13 and 26 08 16. Generally, ETA shall provide their standard forms to document the NETA tests to be incorporated into the Prefunctional Checklist and Functional Performance Tests record.

5. During related tests, execute and document the tests in the approved forms and/or test record.

6. Perform and clearly document all completed Start-up and system operational checkout procedures, providing a copy to the Contractor.

7. Clearly indicate any deficiencies identified during testing and add to an action list for resolution and tracking. The field technicians shall keep a running log of events and issues. Submit handwritten reports of discrepancies, deficient or uncompleted work by others, Contract interpretation requests and lists of completed tests to the Contractor at least twice a week and provide technical assistance in the resolution of deficiencies.

8. Provide skilled technicians to execute testing. Ensure that they are available and present during the agreed-upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

9. Warranty Phase: Perform thermographic imaging of loaded panel at time designated by Electrical Sub-Contractor or Contractor.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.03 TESTING

A. Prefunctional Checklists and Start-up:

1. Follow the Start-up and initial checkout procedures listed in this Section. Start-up and complete systems and sub-systems so they are fully functional, meeting the requirements of the Contract Documents.

2. Prefunctional Checklists shall be complete prior to commencement of a Functional Performance test.

3. Refer to Section 26 08 13 for specific details on required Prefunctional Checklists.

B. Functional Performance Tests:

1. Functional Performance Tests are conducted after system Start-up and checkout is satisfactorily completed.

2. Refer to Section 26 08 16 for specific details on the required Functional Performance Tests.

C. Coordination Between Testing Parties:

1. Factory Start-ups: Factory Start-ups are specified for certain equipment. Factory Start-ups generally are Start-up related activities that will be reviewed and checked prior to Functional Performance Tests. All costs associated with factory Start-ups shall be included with the contract price unless otherwise noted. Notify the Commissioning Team of the factory Start-up schedule and coordinate these factory Start-ups with witnessing parties. The Commissioning Team members may witness these Start-ups at their discretion.
2. Independent Testing Agencies: For systems that specify testing by an independent testing agency, the cost of the test shall be included in the Contract price unless otherwise noted. Testing performed by independent agencies may cover aspects required in the Prefunctional Checklists, Start-ups, and Functional Performance Tests. Coordinate with the independent testing agency so that Owner, CxA and/or AE can witness the test to ensure that applicable aspects of the test meet requirements.

3.04 TRAINING

A. Submit a written training plan to the Owner, CxA and Architect/Engineer for review and approval. Contractor’s training plan shall cover the following elements:

1. Equipment included in training.
2. Intended audience.
3. Location of training.
4. Objectives.
5. Subjects covered.
6. Duration of training on each subject.
7. Instructor for each subject.
8. Methods (classroom lecture, video, Site walk-through, actual operational demonstrations, written handouts, etc.).
9. Instructors and qualifications.

B. Contractor shall have the following training responsibilities:

1. Provide a training plan fourteen (14) calendar days prior to the scheduled training, in accordance with Division 01.
2. Provide Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned equipment or system.
3. Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including Start-up, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This representative may be the Start-up technician for the piece of equipment, the installing contractor, or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The training sessions shall follow the outline in the Table of Contents of the O&M manual and illustrate whenever possible the use of the O&M manuals for reference.
7. Training shall include:
a. Usage of the printed installation, operation and maintenance instruction material included in the O&M manuals.

b. Review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include Start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.

c. Discussion of relevant health and safety issues and concerns.

d. Discussion of warranties and guarantees.

e. Common troubleshooting problems and solutions.

f. Explanation of information included in the O&M manuals and the location of all plans and manuals in the facility.

g. Discussion of any peculiarities of equipment installation or operation.

8. Hands-on training shall include Start-up, operation in all modes possible, including manual, shutdown, and any emergency procedures and maintenance of all pieces of equipment.

9. Training shall occur after Functional Performance Tests are complete and shall be scheduled with the Owner’s Project Manager.

10. Provide training on each system/piece of equipment as specified in other sections.

END OF SECTION 26 08 00
SECTION 26 08 13 – ELECTRICAL SYSTEMS PREFUNCTIONAL CHECKLISTS AND START-UPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section expands on and defines responsibilities of the Contractor regarding Prefunctional Checklists and start-up portions of the Commissioning process and addresses validation of proper and thorough installation of mechanical, plumbing and fire protection systems.

B. Contractor shall oversee the Commissioning activities with the Contractor’s Subcontractors and the Architect/Engineer (AE).

C. Contractor shall completely install, thoroughly inspect, start-up, test, adjust and integrate Electrical Testing Agency (ETA) on systems and equipment. All activities shall be documented on specific, procedural forms developed for that purpose. Contractor shall notify AE and Owner in writing that systems are complete and ready for verification and Functional Performance Tests.

D. Completed Prefunctional Checklists for all pieces of equipment shall be submitted to the Owner prior to Functional Performance testing.

E. Responsibilities of the various parties involved in the Commissioning process are defined in Section 26 08 00.

F. Refer to Attachments A, B, C, and D at the end of this Section for example forms that indicate level of documentation required for the Commissioning process.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 SUBMITTALS

A. Prefunctional Checklists, Prefunctional Tests, and Start-up documents are the normal procedure of ensuring that the system components are properly installed.

B. The Subcontractor in cooperation with the CxA, AE and Contractor shall develop Prefunctional Checklists and Prefunctional Tests during the Construction Phase.
C. Completeness of Prefunctional Checklists: This Section summarizes the minimum standard for systems and equipment checkout. A record of testing and acknowledgement that a procedure has been completed and that it checks out acceptably must be included in the Prefunctional Checklists. The Prefunctional Checklist shall identify in columnar format each device, location, test method, control sequence of operation reference, device code reported, and other data as appropriate.

D. Equipment Data Documentation: Provide completed, as-installed, specific product nameplate data, product numbers, serial numbers, etc. to fully define the asset for Owner’s use in maintenance management and asset tracking. This data may be incorporated within an Equipment List/Matrix as a spreadsheet format or electronic database. In addition to specific manufacturer’s name and specific product identifiers such as model number, serial numbers, date of manufacture, etc., the following information shall be included with the equipment data documentation:

1. Capacity data: Where applicable, use equipment schedules on the Drawings as a guideline for fields to be used.

2. Location identifier field for each of the three dimensions (Floor Level, X axis, and Y axis) using the Drawing column grids as the basis for location.

E. Submit the equipment data documentation with the draft Prefunctional Checklists to the Owner for approval. CxA, AE and Owner will review the Prefunctional Checklists and request any additional information required to meet the Commissioning Plan criteria.

F. Written Certification: The Contractor shall certify that the installation, Start-up, Prefunctional Checklist, and initial operation of the system or component is in accordance with the Contract Documents, Commissioning Plan, and manufacturer’s requirements, and that the system is ready for Functional Performance Tests. Any outstanding items or non-conformance shall be clearly indicated and highlighted on the Prefunctional Checklist and an action item shall have been initiated. Refer to Division 01 for specific details on non-conformance issues relating to Prefunctional Checklists.

G. Refer to Section 26 08 00 for additional documentation requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. The Prefunctional Checklist procedures described in this Section provide minimum guidelines for development of Prefunctional Checklists; Start-up procedures, and Prefunctional Tests. Contractor shall prepare the Prefunctional Checklists using these procedures and that of the manufacturer’s and/or applicable codes and standards.

C. The Prefunctional Checklist form shall acknowledge that installation and Start-up procedures were successfully adhered to and completely performed and shall document relevant parameters (panel and equipment connections, measured values, ground faults, trip settings, etc.). When indicated as performing a checkout on multiple items or multiple procedure items, Prefunctional Checklist forms shall itemize each individual item.

D. Provide temporary/permanent control power so operation of digital metering, HMI and control sequences can be verified prior to utility energizing the feeders.

2.02 TEST EQUIPMENT

A. Refer to Section 26 08 00 – Electrical Systems Commissioning.
PART 3 - EXECUTION

3.01 PREFUNCTIONAL CHECKLIST PROCEDURES

A. Thermographic Scanning:
   1. Contractor shall provide thermographic scanning on all switchgear and distribution boards. In general, the thermographic scanning shall be made when the equipment is energized and is operating at its normal capacity. It is intended that the scan be made after the equipment has been in full operation; however, the Contractor near the completion of the Project will determine the exact time of conducting the scan. Some scanning for occupant-created load shall be performed during the Warranty Period as a Deferred Test.
   2. Test equipment, miscellaneous tools, and materials shall be transported properly, moved, and set up by trained personnel. Equipment used in testing shall be capable of performing all recommended procedures required by the apparatus and related equipment. All test equipment shall have certification of calibration and be in working order.
   3. All hot spots shall be marked, identified, and an infrared thermographic scanning report prepared and furnished to the Owner.
   4. The report shall contain infrared photos of trouble spots with temperature readings.
   5. The Contractor shall promptly report all sources of heating problems to the Owner for corrective action.

B. Grounding Systems:
   1. Perform three-point fall-of-potential test per Institute of Electrical and Electronics Engineers (IEEE) Standard 81 on the main grounding electrode or system. Resistance shall be no greater than 5 ohms.
   2. Perform the two-point method test per IEEE Standard 81 to determine the ground resistance between the main ground system and all major electrical equipment frames, system neutral, and/or derived neutral points. Resistance shall be no greater than 5 ohms.
   3. Refer to Section 26 05 26 GROUNDING.

C. AC Motors – General Across Systems:
   1. Verify proper alignment, installation, and rotation.
   2. Measure the insulation resistance, phase balance, and resistance to ground. This measurement will generally be the responsibility of the electrical Subcontractor who is connecting the motor. Correction of any deficiencies will be the responsibility of the motor supplier. Where the electrical Subcontractor wires to a single point of a packaged device that is shipped with multiple motors, electrical Subcontractor shall check all motors in the package.
   3. Verify that properly sized overloads are in place.
   4. Measure voltage available to all phases at time of initial connection and again after motor has been placed in operation under load measure amps and RPM.
   5. Record all motor nameplate data.

D. Medium Voltage Feeders:
   1. Start-up checklists: Perform the following final checks before Start-up:
a. Inspect underground duct banks.

b. Inspect cable and perform field testing on reels.

c. Inspect splicing and terminations. Medium voltage terminations at existing “Mid-Way” Switchgear is by owner.

2. Starting Procedures: Follow the manufacturer’s written procedures and the following as a minimum:
   a. Visually and mechanically inspect to include the following: Exposed cable, compression type terminations, splices where approved by the Engineer and the Owner, and fire proofing in manholes, cable vaults, etc.
   b. Correct color code identification and phasing arrangements.
   c. Perform shield continuity test.
   d. Perform insulation resistance test on new and existing cables.
   e. Perform high potential test on new cables only.

3. Refer to Section 33 71 49 MEDIUM VOLTAGE CABLES.

E. Medium Voltage Primary Load Interrupter Switches:

   1. General: Provide the services of a factory-trained manufacturer’s representative to assist the Contractor in the installation and start-up service of the equipment and to train Owner's personnel as specified.

   2. Start-up checklists: Perform the following final checks before Start-up:
      a. Inspect incoming power cable terminations.
      b. Inspect grounding.

3. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:
   a. Visually and mechanically inspect to include the following: anchoring, grounding, torque of bus and cable connections, and mechanical operation of switch and operating mechanisms.
   b. Perform contact resistance test.
   c. Perform insulation resistance tests on switch and control wiring.
   d. Perform mechanical (key) interlock system operations.

F. Medium Voltage Transformer:

   1. Provide the services of a factory-trained manufacturer’s representative to assist the Contractor in the installation and start-up service of the equipment and to train Owner's personnel as specified.

   2. Start-up checklists: Perform the following final checks before Start-up:
      a. Inspect primary and secondary power connections.
      b. Inspect control interconnections.
c. Inspect grounding.

3. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:
   a. Visually and mechanically inspect to include the following: vibration isolation, anchoring, grounding, installation verification using manufacturer’s checklist, flexible bus connections, torque of bus and cable connections, and tap changer operation.
   b. Verify operation of temperature controls/alarms.
   c. Perform winding insulation tests.
   d. Conduct turns ratio test.
   e. Perform power factor/dissipation test on windings and bushings.
   f. Perform medium voltage and low voltage winding and core resistance measurements.
   g. Check and confirm percentage of impedance is identical for all transformers comparing nameplates.

G. 600V Disconnect Switches/480V Secondary Distribution:
1. Provide the services of a factory-trained manufacturer’s representative to assist the Contractor in the installation and Start-up service of the equipment and to train Owner's personnel as specified.
2. Start-up checklists: Perform the following final checks before Start-up:
   a. Inspect connections.
   b. Inspect grounding.
   c. Verify control interconnections.
   d. Check installation of warning nameplates.
3. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:
   a. Visually and mechanically inspect to include the following: anchoring, grounding, torque of bus/cable connections, and mechanical operation of switch and operating mechanisms.
   b. Conduct insulation resistance tests on switch and control wiring.
   c. Conduct contact resistance test.

H. 600V Service Switchgear/480V Secondary Distribution:
1. Provide the services of a factory-trained manufacturer’s representative to assist the Contractor in the installation and Start-up service of the equipment and to train Owner's personnel as specified.
2. Start-up checklists: Perform the following final checks before Start-up:
   a. Inspect connections to main breakers.
   b. Inspect grounding.
   c. Inspect feeder connections to busways and cables.
d. Inspect installation of main, tie and feeder breaker elements.

e. Inspect control and alarm interconnections.

f. Check calibration/setting of trip devices using system coordination study.

g. Verify calibration/setting of digital metering.

3. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

   a. Visually and mechanically inspect to include the following: anchoring, grounding, torque
      of feeder and incoming bus duct connections, feeder cable and integral main bus
      connections, switchgear section alignments, electrical clearances, mechanical operation of
      breaker/fuse drawout elements and operating mechanisms, manual trip function, main bus
      safety shutters, and installation verification using manufacturer's checklist.

   b. Check current and potential instrument transformer ratios.

   c. Conduct insulation resistance and over potential tests on each type of each breaker element
      contacts, switchgear control wiring, breaker element control wiring and each bus section.

   d. Conduct resistance test through switchgear bus joints.

   e. Conduct current test using primary or secondary current injection.

   f. Conduct phasing test on double-ended switchgear.

   g. Conduct contact resistance test on each type breaker element.

   h. Conduct ground resistance test.

   i. Conduct operational/functional tests of protective relaying. Time-current tests shall be
      conducted and trip points shall be set per Architect/Engineer’s direction.

   j. Conduct operational/functional tests of digital metering.

   k. Perform electrical and mechanical (key) interlock system operational tests on service
      switchgear.

I. Human-Machine Interface (HMI):

   1. Provide the services of a factory-trained manufacturer’s representative to assist the Contractor in
      the installation and Start-up service of the equipment and to train Owner's personnel as specified.

   2. Inspect control and alarm interconnections.

   3. Review display of single line diagram for accuracy of as-built condition.

J. 600V Feeder and Subfeeders/480V Secondary Distribution:

   1. Start-up checklists: Perform the following final checks before Start-up:

      a. Inspect cable terminations.

   2. Starting Procedures: Follow the manufacturer's written procedures and the following as a
      minimum:
a. Visually and mechanically inspect to include the following: large junction and pull boxes, supports of raceways and cable bus, and compression type terminations.

b. Correct identification and phasing arrangements.

c. Conduct continuity test of each feeder.

d. Conduct insulation resistance test of each feeder.

K. Distribution and Branch Circuit Panelboards/480V/208V/120V Secondary Distribution:

(Appplies to existing Panelboards affected by project)

1. Start-up checklists: Perform the following final checks before Start-up:
   a. Inspect wiring connections.
   b. Conduct insulation resistance tests on new feeders.

L. 600V Branch Circuits/480/208/120V Secondary Distribution:

1. Start-up checklists: Perform the following final checks before Start-up:
   a. Inspect wiring connections.

2. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:
   a. Visually and mechanically inspect to include the following: large junction and pull boxes, supports of raceways, and compression type terminations.
   b. Correct identification and phasing arrangements.
   c. Perform random continuity test of any branch circuit.
   d. Receptacle Polarity Test: Test every receptacle installed or reconnected under this Contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.

M. Lighting Fixtures and Lighting Controls / 277 / 120V Lighting:

1. Provide the services of a factory-trained manufacturer’s representative to assist the Contractor in the installation and Start-up service of the lighting inverter system and train Owner's personnel as specified below. Representative will confirm the proper installation and operation of all system components.

2. Start-up checklists: Perform the following final checks before Start-up:
   a. Ensure all labeling is affixed and accurate.
   b. Verify quantity, type and location of fixtures.
   c. Verify type and location of switches.
   d. Ensure all fixture supports are installed and terminations are tight.
   e. Ensure adequate access is provided to the inverter and that documentation is provided in it.
   f. Ensure all circuits for the loads are energized and ready for testing.
N. Fire Alarm Equipment / Fire Alarm and Detection System:

1. Provide the services of a qualified fire alarm specialist to supervise the installation, make adjustments, and perform tests on the fire alarm system and to train Owner's personnel.

2. Start-up checklists: Perform the following final checks before Start-up.
   a. Ensure all labeling is affixed and accurate.
   b. Ensure all terminations are tight.
   c. Ensure adequate access is provided to all panels and that documentation of that panel is provided in the panel.
   d. Review that all fire alarm devices as shown on the Fire Protection Signed and Sealed Shop Drawings are installed.
   e. Review height and locations visual alarms to comply with ADA.
   f. Review that smoke and duct detectors are installed according to NFPA 90A.
   g. Check that fire alarm system control panel is clear with no trouble or ground faults.
   h. Check wire supervision on all devices.
   i. Check location of all sensors and switches to ensure conformance with requirements.
   j. Verify interfaces with all other inter-related systems or equipment including building automation system (BAS), Preaction fire protection system, HVAC systems, etc. on a point by point basis for all points.
   k. For Operator Interfaces:
      1) Verify all elements on the graphics are programmed, functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
      2) Output all specified reports for review and approval.
      3) Verify the alarm printing and logging is functional and per requirements.

3.02 ACCEPTANCE CRITERIA
A. Acceptance criteria for tests being tested. Unless indicated otherwise, acceptance criteria will be specified with the individual system, equipment, component, or device.

3.03 TRAINING
A. Training requirements are indicated in the Specification Sections applicable to the systems and in Section 26 08 00 - Electrical Systems Commissioning.

END OF SECTION 26 08 13
REQUEST FOR START-UP/FUNCTIONAL PERFORMANCE TEST

(Check applicable request below)
Request for Initial Startup ______  Request for Owner’s Demonstration ______

Project: ___________________________  Project #: __________________

Identification of Equipment or System: _______________________________________

Location of Equipment or System: _____________________________________________

Specification Section: ____________________ Detail/Drawing Number: ______________

Manufacturer / Supplier: ______________________________________________________

This Date: ____________________  Inspection Requested for (Date): ________________

CONTRACTOR’S CERTIFICATION OF PERFORMANCE:
I hereby certify that the above described equipment or system, has been energized, operated, adjusted, and balanced in accordance with the requirements of the Contract Documents and the manufacturer's recommendations for a sufficient period to confirm that operation complies in all respects with the Contract Requirements.

__________________________________  ______________________________ ___________
Signature     Printed Name    Date

Installing Subcontractor:

__________________________________  ______________________________ ___________
Signature     Printed Name    Date

Manufacturer’s Representative: I hereby certify that I have been personally and actively involved with energizing, operational checkout, adjustments, and balancing of the above described equipment or system; and that such has been accomplished in accordance with the manufacturer's recommendations and is operating correctly.

__________________________________  ______________________________ ___________
Signature - Manufacturer’s Representative  Printed Name    Date

CONFIRMATION or COMMENTS from Owner:

____________________________________________________________________________
Results of Test Acceptable? ____YES ____NO  Re-Test Required? ____YES ____NO
Punch List: _____Attached  _____To Follow  _____N/A
System Acceptable for "User Training"? ____Yes  ____No

__________________________________  ______________________________ ___________
Signature(s) – University of Missouri – Facility Manager  Printed Name(s) – University of Missouri    Date

__________________________________  ______________________________ ___________
Signature(s) – University of Missouri – Project Manager  Printed Name(s) – University of Missouri    Date

ATTACHMENT “A” TO ELECTRICAL SYSTEMS PREFUNCTIONAL CHECKLISTS AND START-UPS
CP191241  260813 - 1  AUGUST 7, 2019
NORMAL POWER UPGRADES
EXAMPLE - PREFUNCTIONAL CHECKLIST
Switchgear, Panelboards, Motor Control Centers, Transformers

Project: ___________________________  Project #: ______________________

Identification of Equipment or System: ________________________________

Location of Equipment or System: _______________________________________

Specification Section: __________________ Detail/Drawing Number: __________

Manufacturer / Supplier: ________________________________________________

This Date: _______________  Inspection Requested for (Date): ________________

Prefunctional Checklist Number: __________________

Components Included: ____Disconnects ____Fuses ____Meters ____Other

Associated Prefunctional Checklists: __________________  __________________

1. General:
   a. The above systems and components integral to this equipment are complete and ready for
      Functional Performance Tests. The Prefunctional Checklist items are complete and have
      been checked off only by parties having direct knowledge of the event, as indicted below,
      respective to each responsible contractor. This Prefunctional Checklist is submitted for
      approval and is subject to the attached list of outstanding items not completed successfully.
      Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the
      outstanding items preclude safe and reliable functional tests being performed.
   b. ____ Deficiency Form attached.
   c. This Prefunctional Checklist does not take the place of the manufacturer’s recommended
      checkout and Start-up procedures or report.
   d. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be
      responsible to ensure that their subcontractors complete and check off their Checklist items.
   e. Prefunctional Checklist items shall be completed as part of Start-up and initial checkout,
      preparatory to functional testing.
<table>
<thead>
<tr>
<th>Contractor/Entity</th>
<th>Company</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MU HealthCare Staff</td>
<td></td>
<td>MUHC</td>
</tr>
<tr>
<td>Architect/Engineer</td>
<td></td>
<td>AE</td>
</tr>
<tr>
<td>General Contractor / Construction Manager</td>
<td></td>
<td>GC</td>
</tr>
<tr>
<td>Mechanical Contractor</td>
<td></td>
<td>MC</td>
</tr>
<tr>
<td>Electrical Contractor</td>
<td></td>
<td>EC</td>
</tr>
<tr>
<td>Building Automation System Provider</td>
<td></td>
<td>BAS</td>
</tr>
<tr>
<td>Test, Adjust, and Balance Firm</td>
<td></td>
<td>TAB</td>
</tr>
<tr>
<td>Commissioning Agent</td>
<td></td>
<td>CxA</td>
</tr>
</tbody>
</table>

2. Requested Documentation Submitted:

<table>
<thead>
<tr>
<th>Specified Requirement</th>
<th>Yes</th>
<th>No</th>
<th>Date to be Submitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Manufacturer’s Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Required Test Reports and/or Certifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Installation and Start-up Manual and Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Wiring Diagrams, Control Schematics and Sequences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Operating and Maintenance Manual Content for Applicable System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Equipment List/Matrix</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Equipment Verification:

<table>
<thead>
<tr>
<th>Item</th>
<th>Specified</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Rating (amps)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage/Phase</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Installation Checks:

<table>
<thead>
<tr>
<th>a) Unit and General Installation</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Permanent labels affixed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Physical condition acceptable, no visible damage, cabinets in place</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Properly mounted on equipment pad and anchored</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Maintenance access acceptable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Interior clean and dry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Meter(s) installed per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Disconnects installed and labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Disconnects are pad lockable in open position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Circuit breakers installed and labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Fuses installed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### a) Unit and General Installation

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>Conduits installed and connected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Cable/conduit routing does not obstruct access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Equipment room properly ventilated, air-conditioned, heated, fire/smoke wall separated, fire/smoke dampered, fire sprinklered, fire alarmed and illuminated (normal, emergency and battery backed-up fixtures)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>As-built drawings updated</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### b) Switchgear (service entrance 1500kVA and above) and Switchboards (service entrance less than 1500 kVA)

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Free standing metal enclosure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Copper buses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Penetration to utility service area and equipment per code</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### c) Distribution Panelboards and other Panelboards

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tin plated copper buses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Each circuit identified and labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Space for additional circuits exist</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### d) Motor Control Centers

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tin plated copper buses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Main breakers installed and labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Each circuit identified and labeled</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### e) Transformers

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dry type installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Unit properly labeled and identified</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### f) Electrical and Controls

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Panel devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>I/O devices labeled and wiring tagged per Contract Documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Digital inputs and outputs operational</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>All electrical connections tight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Proper grounding installed for the electrical system, equipment, components, and unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Safeties in place and operable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Meters calibrated (see below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Control system interlocks hooked up and functional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>All control devices and wiring complete</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>10.</td>
<td>Main-Tie-Main Logic Programming Completed by Manufacturer</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>12.</td>
<td>Surge protection installed</td>
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</table>
### g) Final

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start-up report completed and attached with this Prefunctional Checklist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safeties and safe operating ranges for this equipment have been reviewed and accepted</td>
<td></td>
<td></td>
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<tr>
<td>3.</td>
<td></td>
<td></td>
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<tr>
<td>System is ready for Functional Performance Test</td>
<td></td>
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</tr>
</tbody>
</table>

5. **Operational Checks:**

   a. These checks supplement the manufacturer’s list. This is not the Functional Performance Test.

    | Yes | No | Comments |
    |-----|----|----------|
    | 1.  |    |          |
    | Associated Prefunctional Checklists are complete and accepted | | |
    | 2.  |    |          |
    | Fuses are good | | |
    | 3.  |    |          |
    | Resistance check(s) complete with results attached | | |
    | 4.  |    |          |
    | Disconnect switch operates smoothly with full contact | | |
    | 5.  |    |          |
    | Specified point-to-point checks have been completed and documentation record submitted for this system | | |

6. **Meter Calibration:**

   a. All field-installed meters on this piece of equipment shall be calibrated. Meters installed in the unit at the factory with calibration certification provided are not required to be field calibrated.

   b. All test instruments have had a certified calibration within the last 12-months: Y / N

   c. All meters are calibrated within required tolerances ___ YES ___ NO
Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.

<table>
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<tr>
<th>General Contractor:</th>
<th>Print Name:</th>
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<tr>
<td></td>
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<tr>
<th>Electrical Subcontractor</th>
<th>Print Name:</th>
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<th>Other Subcontractor:</th>
<th>Print Name:</th>
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<td></td>
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<td>Date:</td>
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Prefunctional Checklist received and reviewed for completeness by MU HEALTHCARE representatives. Functional Performance Test can proceed.

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<td></td>
<td>Title:</td>
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<td>Date:</td>
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SECTION 26 08 16 – ELECTRICAL SYSTEMS FUNCTIONAL PERFORMANCE TESTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section expands on and defines responsibilities of the Contractor in regards to Functional Performance Tests (FPT’s) of the Commissioning process.

B. Contractor shall oversee the Commissioning activities with the Contractor’s Subcontractors and the Architect/Engineer (AE).

C. Prefunctional Checklists, tests and Start-ups are to be completed and documented for the record prior to commencing with FPT’s. Refer to Section 26 08 00 and 26 08 13 for additional requirements.

D. Completed FPT Forms for all pieces of equipment and systems shall be submitted to the Owner prior to Substantial Completion.

E. Refer to Attachments A and B at the end of this Section for example forms that indicate level of documentation required for the Commissioning process.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with all applicable requirements and standards.

1.04 SUBMITTALS

A. Maintain and use an action item tracking system, “Action Item List,” that indicates as a minimum, required information, identified deficiencies, work required, etc.). Each item shall be tracked with the initiator, the parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms. Action Item List shall be distributed and documented using Microsoft Excel or a database format approved by Owner.

B. Disseminate this list as appropriate to keep all parties involved with the FPT informed.

C. Functional Performance Test procedure forms must include the following:

1. System and equipment or component name(s).

2. Equipment location and identification number in the Equipment List/Matrix.
3. Unique test identification number and reference to unique Prefunctional Checklist and Start-up Documentation Identification Numbers for the equipment.

4. Date and time of test.

5. Project name.

6. Participating parties.

7. Specific sequence of operation or other specified parameters, including performance data being verified.

8. Instructions for setting up a Functional Performance Test.

9. Specific script-type, step-by-step procedures to perform a Functional Performance Test, in a clear, sequential and repeatable format that is customized for the system being tested.

10. A Yes/No checkbox (or data entry box as appropriate) for clearly indicating whether or not proper performance of each part of a Functional Performance Test was achieved with space for actual readings.

11. Section for comments.

12. Signatures and date block for participants and Owner approvals.

D. Refer to Division 01 and 26 08 00 for additional documentation requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 TEST EQUIPMENT

A. Refer to Section 26 08 00 – Electrical Systems Commissioning.

PART 3 - EXECUTION

3.01 PREPARATION

A. The objective of FPT’s is to demonstrate that each system operates according to the Contract Documents through all specified modes of operation.

B. Contractor shall operate each system through all modes of operation (Main-Tie-Main scenarios, etc.) where there is a specified system response. Verification of each sequence in the sequences of operation is required.

C. All equipment, components and devices applicable to the FPT must be started and this Start-up must be documented. Refer to Section 26 08 13 for additional Prefunctional Checklist and Start-up requirements.

D. Unless specifically agreed to by the Commissioning Team, all support systems shall be complete prior to FPT.

E. Commissioning Team members shall assist in development and review of the optimal sequence of testing.
3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.03 FUNCTIONAL PERFORMANCE TEST PROCEDURES

A. The purpose of a Functional Performance Test is to verify and document compliance with the stated criteria of acceptance. Contractor shall develop specific script-type test procedures and associated test forms to verify and document proper operation of each piece of equipment and system.

B. Contractor shall operate, or cause to be operated, each system, device, or equipment item, both intermittently and continuously, for duration a period as indicated in the Specification Section(s) for such item and/or in accordance with the manufacturer's written recommendations, the Contract Documents, and the Commissioning Plan.

C. Contractor shall operate each component device and each building system to the full extent of its capability, from minimum to maximum, and under automatic control and manual control.

D. Contractor and manufacturer's representatives shall supervise and coordinate adjustments of all devices and systems for proper operation prior to requesting the Functional Performance Test(s).

E. Sampling: Some types of identical equipment (such as circuit breakers, receptacles etc.) will be tested using a sampling strategy.

F. Failure Limit on Sample Tests: With the sampling percentages is listed a failure limit. This limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.

1. Where sample tests involve multiple systems (ie: checking breaker in different switchboards) the maximum failure limit will apply per system.

G. Deferred Tests: Contractor shall schedule with the Owner and complete Deferred Tests as part of this Contract during the Warranty Period. Testing procedures shall be repeated and/or conducted as necessary. Deferred tests will be required where scheduling prohibits thorough testing in all modes of operation.

H. Provide and deliver the required submitted documentation convenient to testing area. Validate that all required documentation has been submitted to the Owner and is per the Contract Document requirements.

I. Review the Start-up documentation at the start of FPT’s. Ensure that any items indicated as outstanding in the Prefunctional Checklist is entered as an Action Item and enter one if it is not. The Prefunctional Checklists and Start-up tests.measurements shall be spot checked at the beginning of FPT’s to ensure accuracy. Complete a test that indicates Contractor has reviewed the Prefunctional Checklists and finds the Prefunctional Checklists acceptable and notes any outstanding items.

J. Check for and as applicable direct the Subcontractor to demonstrate that access is sufficient to perform required maintenance.

K. Validate that all prerequisite work is complete and confirm this validation via a test record for documentation.

L. Specifically check labeling and ensure conformance to the Contract Documents.

M. Check proof indication, alarming on failure and restart/acknowledgement as applicable.
N. Observe operating conditions encountered at the start of the FPT. Contractor shall examine for normal functionality and record parameters as a test.

O. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on Main-Tie-Main systems shall be tested on all sources. This test shall generally be coordinated with electrical power systems testing addressed in the Contract Documents.

P. Inspect the installation and compare it to the Contract Documents. Record the inspection as a test.

Q. Capacities and adjusted and balanced conditions as applicable will generally be checked.

R. Verify all sequence modes and sequences of operation. Contractor must initiate all modes and may not refer to or rely on a Prefunctional Test done by the building automation system. Some examples of generic modes that apply to most systems include:
   1. Off mode.
   2. Failed mode: Proof, safeties, power outage etc. See below for crash testing.
   3. Start sequence in various modes.
   4. Stop sequences in various modes.

S. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation. The Contractor is responsible for placing systems in optimal condition for occupancy and not simply relying on initial design estimated settings.

T. Dynamic Graphics: The graphic for all components, systems, and areas sampled and required to be represented by a graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints are required to be adjustable, verify that they can be adjusted directly from the graphic screen.

U. All interfaces between two systems or equipment of different manufacturers must be checked for accuracy and functionality.

V. “Crash Testing”: Contractor shall analyze systems to identify possible conditions where functionality may be compromised. Contractor shall design non-destructive tests that will demonstrate either the automated response to the conditions or so that team can identify the best method for responding or fixing the condition. All tests and their findings shall be documented in a Microsoft Excel spreadsheet.

3.04 SPECIFIC SYSTEM FUNCTIONAL TEST PROCEDURES

A. Switchgear:
   1. Participants shall include Contractor, Electrical Subcontractor, and Commissioning Team.
   2. Review the Start-up documentation.
   3. Spot check breaker settings against Short Circuit Study.
   4. Inspect for conformance to Contract Documents in concert with reviewing the ETA reports.
   5. Contractor shall incorporate the ETA reports into the Microsoft Excel software.
   6. Open medium voltage normal power feeder breakers to simulate various levels of power outages including all utility feeds, single feed, transformers, and distribution panels. All medium voltage breakers in “Mid-Way” Switchgear shall be operated by the owner.
   7. With each partial outage, record timing parameters of tie breaker closure.
8. Restore normal breakers and observe systems retransfer to normal operating conditions. Record timing of tie breakers opening.

9. Validate the digital metering integral to the switchboard. The Utility Revenue Metering outlined in Section 33 71 73.33 shall be installed and programmed by the Owner.

10. Test the manual tie operation and mechanical (key) interlocks.

B. Distribution Transformers:

1. Participants shall include Contractor, Electrical Subcontractor, and Commissioning Team.

2. Test all transformers.

3. Review Start-up documentation.

4. Spot check insulation resistance and polarity for each type of transformer to ensure they are per the requirements.

C. Tie Breakers:

1. Participants shall include Contractor, Electrical Subcontractor, and Commissioning Team.

2. Sample 50 percent.

3. Test operation by opening normal breakers. Record timing parameters of breaker closure and coordination with other breakers.

4. Test manual tie operation and key lock out.

D. Human-Machine Interface (HMI):

1. Participants shall include Contractor, Electrical Subcontractor, and Commissioning Team.

2. Review the Start-up documentation.

3. Review display of all metering data and status indicators and check for accuracy.

4. Test Main-Tie-Main remote operation per the specified Sequence of Operations.

E. Lighting and Lighting Inverter System:

1. Participants shall include Contractor, Electrical Subcontractor, and Commissioning Team.

2. Spot check the lighting systems Start-up and ensure that the all fixtures are operational and clean.

3. Check all switches to ensure proper operation and circuiting.

4. Individually check all lighting panel schedules to ensure that room numbers and areas are correctly listed and they are programmed per the Owner Representative’s direction.

5. Test operation of inverter by interrupting power supply to demonstrate all fixtures are operational. Verify transfer from normal power to battery and retransfer to normal.

F. Fire Alarm System:

1. Participants shall include Contractor, Electrical Subcontractor, MU HEALTHCARE Environmental Health & Safety, and Commissioning Team.

2. Spot check location of sensors and switches to ensure conformance with requirements.
3. Verify sampling of all types of devices. Cause activation of the device, assure alarms are initiated and resulting response is per the requirements.

4. Verify interfaces with all other inter-related systems or equipment including building automation system (BAS), pre-action fire protection system, HVAC systems, etc. on a point by point basis for all points.

5. Validate output devices (speakers and strobes) meet the code criteria (96 dBa at 10 feet and 117 candela at peak).

6. Test all functions and sequences associated with the pre-action fire protection system.

7. Activate sprinkler flow switches. Validate that appropriate zone enunciates and alarms sound.

8. Verify audio aspects of the system function as required. Verify paging messages can be heard.

9. Ensure that the system functions while using all sources of power including normal, emergency, and battery. Check battery life by simulating an extended outage.

3.05 PARTICIPATION

A. Required participating parties are indicated with the individual tests. Typically, multiple parties are required for any given test, yet participation for any given party is only required for the respective portion of the test for which the party is responsible. In many cases, the maximum required time in hours is indicated in parenthesis for any given test. The time is typically per unit system unless indicated otherwise. If no time is indicated, participation is required throughout the entire test.

B. Frequently, on multiple samples where a given party does not directly conduct the test, the participation of that party will only be required for an initial quantity of systems/equipment. It is required that the parties be available on-site throughout the testing of any given system for which they are required participants. Therefore time for which they are not directly involved can be spent performing other work (typically addressing identified punch list items or failed test).

C. No party involved with the Project is prohibited from participation in or witnessing of any tests. Any Subcontractor may elect to witness all tests on their systems even if their involvement is not directly required.

D. Coordinate effectively with the individual Subcontractors throughout the development and execution of FPT’s and maximize Subcontractors’ involvement.

3.06 NON-CONFORMANCE

A. Record results of Functional Performance Tests. Contractor shall report all deficiencies and non-conformance issues to Owner on the Functional Performance Test report form and in a Commissioning deficiency report.

B. At the sole discretion of Owner, Owner may permit the Contractor to make corrections of minor deficiencies observed during a Functional Performance Test. However, the Contractor must document the deficiency and resolution on the appropriate report form.

C. Contractor and Owner will attempt to resolve deficiencies in the following manner:

1. When there is no dispute about a deficiency and Contractor accepts responsibility for correction.
   a. Contractor documents the deficiency and the corrective actions, and then proceeds to another test or sequence. Contractor submits a deficiency report to Owner. Contractor corrects the deficiency, completes the statement of correction form certifying that the equipment or system is ready for retesting, and sends the certification to Owner.
b. Contractor reschedules test with Owner.

2. When there is a dispute about whether or not the test indicates a Deficiency, or the Contractor’s responsibility for the correction of the apparent Deficiency.
   a. Contractor documents the apparent Deficiency and proceeds to another test or sequence. Contractor submits a Deficiency report to Owner, including the apparent Deficiency.
   b. Contractor facilitates resolution of Deficiency and provides recommendations to the Owner. Contractor and Owner may bring other parties into the discussions as needed. Final technical interpretive authority is with the Architect/Engineer. Final acceptance authority is with the Owner.
   c. Contractor documents resolution process.
   d. If Owner agrees with Contractor’s interpretation and proposed resolution, Contractor forwards response to Owner. Contractor reschedules test with Owner. Contractor must repeat this process until satisfactory performance and Owner’s approval is obtained.

3.07 ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in the Specification Sections applicable to the systems being tested. Generally, unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device.

END OF SECTION 26 08 16
EXAMPLE – FUNCTIONAL PERFORMANCE TEST
Switchgear

Project: ________________________________ Project #: ______________________

Identification of Equipment or System: ________________________________________

Location of Equipment or System: ____________________________________________

Specification Section: ________________ Detail/Drawing Number: ________________

Manufacturer / Supplier: ______________________________________________________

This Date: _____________ Time of Test: _____________

Functional Performance Test Procedure Number: __________________

Prefunctional Checklist Number: ___________

Components Included:
___ Transformer, ___ Main-Tie-Main, ___ HMI, ___ Circuit Breakers

Other Related Functional Performance Tests: ________________________________

1. General:

This Functional Performance Test is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Commissioning Deficiency Report upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.

2. ___ Commissioning Deficiency Report attached.

3. Participants:

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Role/Participation</th>
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ATTACHMENT “A” TO ELECTRICAL SYSTEMS FUNCTIONAL PERFORMANCE TESTS
26 08 16 A
1 OF 3
4. Functional Performance Test Prerequisites:

<table>
<thead>
<tr>
<th>Specified Requirement</th>
<th>Yes</th>
<th>No</th>
<th>Date to be Submitted</th>
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</thead>
<tbody>
<tr>
<td>a) The Prefunctional Checklist for this system is complete and approved</td>
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<tr>
<td>b) The Prefunctional Checklist for the switchgear and related accessories is complete and approved</td>
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<tr>
<td>c) All Architect/Engineer punchlist items for this system and related equipment have been addressed and corrected</td>
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<td>d) Sequence of operation is attached</td>
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<tr>
<td>e) These Functional Performance Test procedures have been reviewed and approved by installing contractor and applicable subcontractors</td>
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5. Functional Performance Test Procedure:

<table>
<thead>
<tr>
<th>Step</th>
<th>Mode</th>
<th>Test Procedure</th>
<th>Expected Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Incremental</td>
<td>Functional Performance Test No. 1: Open Line A (preferred) utility feeder overcurrent protective device. Perform test and record data. At end of test, restore normal power.</td>
<td>Verify that: Line A Main Circuit Breaker opens. Line B Main Circuit Breaker and Tie Circuit Breaker Closes and Power has been transferred to Line B.</td>
</tr>
<tr>
<td>2</td>
<td>Incremental</td>
<td>Functional Performance Test No. 1: Close Line A utility feeder overcurrent protective device. Perform test and record data. At end of test, restore normal power.</td>
<td>Verify that: Line B Main Circuit Breaker opens. Line A Main Circuit Breaker and Tie Circuit Breaker Closes and Power has been transferred to Line A.</td>
</tr>
<tr>
<td>3/4</td>
<td>Incremental</td>
<td>Repeat Steps 1 and 2 above with Line B as preferred utility source</td>
<td></td>
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6. Comments:
Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Commissioning Deficiency Report.

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Functional Performance Test procedure received and reviewed for completeness by MU HEALTHCARE representatives. Integrated System Test can proceed.

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SECTION 261116 - SECONDARY UNIT SUBSTATIONS

PART 1 - GENERAL

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

1.02 SUMMARY:
   A. This Section includes indoor secondary unit substations consisting of the following:
      1. Primary incoming section.
      2. Transformer.

1.03 RELATED REQUIREMENTS:
   A. SECTION 337149 - MEDIUM VOLTAGE CABLES for requirements of terminating cables in
      incoming section of substation.
   B. SECTION 262300 - LOW-VOLTAGE SWITCHGEAR.

1.04 SUBMITTALS:
   A. Product Data: Include rated capacities, furnished specialties, and accessories.
   B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required
      clearances, method of field assembly, components, and location and size of each field
      connection.
      2. Dimensioned plans and elevations showing major components and features.
      3. One-line diagram.
      4. List of materials.
      5. Nameplate legends.
      6. Size and number of bus bars and current rating for each bus, including mains and
         branches of phase, neutral, and ground buses.
      7. Short-time and short-circuit current ratings of secondary unit substations and
         components.
      8. Ratings of individual protective devices.
   C. Time-Current Characteristic Curves: For overcurrent protective devices.
   D. Primary Fuses: Submit recommendations and size calculations.
   E. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items
      are shown and coordinated with each other, based on input from installers of the items involved:
      1. Dimensioned concrete base, outline of secondary unit substation and conduit entries.
      2. Location of structural supports for structure-supported raceways and busways.
      3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.
   F. Product Certificates: For secondary unit substations, signed by product manufacturer.
   G. Factory test reports.
   H. Field quality-control test reports.
I. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE:
A. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated.
C. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. Comply with IEEE C2.
E. Comply with IEEE C37.121.
F. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING:
A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
B. Coordinate delivery of secondary unit substations to allow movement into designated space.
C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.07 PROJECT CONDITIONS:
A. Field Measurements: Indicate measurements on Shop Drawings.

1.08 COORDINATION:
A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete bases are specified in DIVISION 26, Section “Hangers and Supports for Electrical Systems.”

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB/GE (Basis of Design).
   2. Eaton.
   3. Square D; Schneider Electric.
2.02 MANUFACTURED UNITS:

A. Indoor Unit Arrangement: Single assembly. Unit substations shall be indoor, 3-phase, 60 Hz type, complete from the 13,800V incoming line connection to the 480/277V or 208/120V outgoing feeder connections.

B. Unit substations shall consist of a primary voltage line section, a transformer section, and a low voltage section, each separated from the others by steel barriers but electrically connected and physically joined to form a single metal-enclosed structure. The enclosure frame and internal barriers shall be fabricated of code gauge steel and finished with manufacturer’s standard gray paint applied over a rust-inhibiting phosphate primer. Construction shall prevent entry of rodents into the substation interior.

C. The equipment shall be completely adjusted and tested at the factory and sectionalized for shipment. Installation and connection of the unit substation shall not require removal or disassembly of any factory-mounted stationary primary voltage devices. Nameplates indicating equipment ratings, tap changing information, manufacturer identification and reference serial numbers shall be mounted on the front of the unit substations.

2.03 INCOMING SECTION:

A. Primary Incoming Section: Duplex, medium voltage load interrupter switches.

   1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame, complying with IEEE C37.20.3.
   2. Key interlocking of primary sources shall not be provided.
   3. Key interlocking system to prevent fuse access door from being opened unless both switches are open.
   4. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
   5. Fuse compartment shall be barriered from switch compartments and bus.
   6. Window: Permits viewing fuses and switch-blade positions when door is closed.
   7. IR windows: Permits scanning of conductor terminations.
   8. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
   9. Continuous-Current Rating: 600A.
   10. Short-Circuit Rating:
       a. 0.5 cycle (momentary) asymmetrical RMS short-circuit rating of 40 kA.
       b. 5-cycle symmetrical interrupting rating of 25-kA.
       c. Close and latch asymmetrical RMS rating of 40 kA.

B. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

   1. 10kV, 8.4kV MCOV
2.04 DRY-TYPE TRANSFORMER SECTION:

A. Transformers:
   1. Temperature rise: 80°C.
   2. Shall be Indoor Dry Type Vacuum Cast Coil construction in accordance with ANSI Standard C57, latest revision.
   3. Shall be constructed of individually cast primary and secondary coils, coaxially mounted. All primary and secondary coils shall be cast.
   4. The core shall be designed to reduce losses due to both the fundamental and harmonic frequencies.
   5. Shall be explosion-resistant, fire-resistant, air-insulated, and cooled by the natural circulation of air through the windings.
   6. The finished primary and secondary coils must be hermetically sealed in epoxy utilizing a proven manufacturing system that demonstrates its ability to minimize hot spots and partial discharge.
   7. Windings: copper in Dyn1 configuration.
   8. Primary and secondary connection: Transition terminal compartment with connection pattern to match switchgear. Connections to switchgear shall be made with flexible bus to minimize vibration.
   9. “Red Phenolic” shall not be used for electrical insulation of any high voltage conductor.
   10. Ratings shall be as follows:
       a. kVA rating: as indicated on the Drawings.
       b. Impedance: 5.75%.
       c. HV: as indicated on the Drawings.
       d. HV BIL: 60 kV
       e. HV taps: two 2.5% full capacity taps above and below nominal voltage
       f. LV: as indicated on the Drawings.
       g. LV BIL: 10 kV.
   11. Nameplate: Stainless Steel, engraved. In addition to normal information, the following items shall be included on the nameplate of each unit:
       a. kVA ratings, AA.
       b. Primary voltage.
       c. Secondary voltage.
       d. Full load secondary current.
       e. BIL ratings.
       f. Temperature ratings.
       g. Primary and secondary voltages for each tap setting.
       h. Primary amperage rating for each tap setting.
       i. Date of Manufacture.
       j. Name of Manufacturer.
       k. Transformer K factor (if included).
       l. Type of conductors in windings.
       m. C/R ratio.
       n. Impedance expressed in percentage.
       o. Detail circuit diagrams.
       p. Delta – wye or delta – delta diagram detailing the relationship of primary to secondary bushings.
       q. Total weight of unit expressed in pounds.
   12. Sound levels shall not exceed the following when measured in accordance with NEMA test procedures:
SECTION 26116 - SECONDARY UNIT SUBSTATIONS: continued

<table>
<thead>
<tr>
<th>Size</th>
<th>Sound Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>701 to 1000 kVA</td>
<td>64 dB</td>
</tr>
<tr>
<td>1001 to 1500 kVA</td>
<td>65 dB</td>
</tr>
<tr>
<td>1501 to 2000 kVA</td>
<td>66 dB</td>
</tr>
<tr>
<td>2001 to 3000 kVA</td>
<td>68 dB</td>
</tr>
</tbody>
</table>

14. Transformer efficiency shall meet or exceed values listed in NEMA TP-1.
15. Transformers shall be supplied in a knockdown case design, for ease in fitting through limited openings, and shall be of heavy gauge sheet steel construction, equipped with removable panels for access to the core and coils. Front and rear panels shall incorporate ventilating grilles.
16. Enclosures shall limit the entry of a #12AWG wire.
17. Transformers shall include: diagram instruction plate, provisions for lifting and jacking, removable insulated case panel for access to primary strap type connector taps for de-energized tap changing, and 2 ground pads.

B. Provide flexible connection to switchgear sections. Cable connections are not permitted. Coordinate requirements with the pneumatic isolator installation instructions.

C. Provide and install neoprene vibration isolation pads of minimum 1” thickness on all substation transformers.

2.05 SECONDARY DISTRIBUTION SECTION:

A. Low voltage sections shall be furnished in accordance with Section 262300, LOW-VOLTAGE SWITCHGEAR.

2.06 IDENTIFICATION DEVICES:

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in DIVISION 26, Section "Identification for Electrical Systems."

2.07 SOURCE QUALITY CONTROL:

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear tests according to ANSI C37.51. The equipment shall be completely adjusted and tested at the factory and sectionalized for shipment. Perform the following factory-certified tests on each secondary unit substation:
1. An induced partial discharge test shall be performed on each winding. The induced partial discharge test shall be performed by measuring partial discharge levels beginning at 80% rated voltage and continuing in 10% step increments through 200% rated voltage. Partial discharge inception and extinction levels are defined as levels above 10 Pico-Coulombs and shall be recorded. Acceptance criteria is partial discharge extinction at or above 120% rated voltage.
2. The following factory tests shall be made on each transformer in accordance with ANSI/IEEE C57.12.90:
   a. Resistance measurements of windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on this Project.
   b. Ratio tests on the rated voltage connection and on tap connections.
   c. Polarity and phase-relation tests on the rated voltage connection.
   d. No-load loss at rated voltage on the rated voltage connection.
   e. Exciting current at rated voltage on the rated voltage connection.
   f. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on this Project.
   g. Temperature test.
   h. Applied potential test.
   i. Induced potential test.
B. Results of the above tests shall be submitted with final drawings in the form of certified test reports.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.
   B. Examine roughing-in of conduits and grounding systems to verify the following:
      1. Wiring entries comply with layout requirements.
      2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
   C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.
   D. Verify that ground connections are in place and that requirements in DIVISION 26, Section "Grounding" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
   E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Install secondary unit substations on concrete bases.
      1. Anchor secondary unit substations to concrete bases according to manufacturer’s written instructions and requirements in DIVISION 26, Section "Hangers and Supports for Electrical Systems."
   B. Maintain minimum clearances and workspace at equipment according to manufacturer’s written instructions and NFPA 70.

3.03 IDENTIFICATION:
   A. Identify field-installed wiring and components and provide warning signs as specified in DIVISION 26, Section "Electrical Identification."
   B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency
3.04 CONNECTIONS:

A. Ground equipment according to DIVISION 26, Section "Grounding"
B. Connect wiring according to DIVISION 26, Section “Low-Voltage Electrical Power Conductors and Cables” and DIVISION 33, Section “Medium Voltage Cables.”

3.05 CLEANING:

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.06 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connection, and to assist in field testing. Report results in writing.
B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
   2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
   3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
   4. Set field-adjustable switches and circuit-breaker trip ranges as directed by Engineer.
   5. Remove and replace malfunctioning units and retest as specified above.

3.07 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 261116
SECTION 262300 - LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY:

A. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1,000V and less for use in AC systems.

1.03 REFERENCE STANDARDS:

A. American National Standards Institute (ANSI):
   1. C12.7 – Requirements for Watthour Meter Sockets
   2. C12.11 – Instrument Transformers for Revenue Metering 10 kV BIL through 350 kV BIL

B. American Society for Testing and Materials (ASTM):

C. Institute of Electrical and Electronic Engineers (IEEE):
   2. IEEE C12 – Electricity Metering Standards
   3. 141 - Recommended Practice for Electric Power Distribution for Industrial Plants.
   4. 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

D. National Electrical Manufacturers' Association (NEMA):
   1. FU 1 - Low Voltage Cartridge Fuses.
   2. LA 1 - Surge Arresters.

E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

F. National Electrical Testing Association (NETA):

G. Underwriters Laboratories (UL): Provide equipment and components which are UL - listed and labeled.
   1. UL 467 - Grounding and Bonding Equipment.
   3. UL 512 - Standard for Fuseholders.
   4. UL 1558 - Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear.
SUBMITTALS:

A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each type of switchgear and related equipment.
1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
   a. Location of infrared (IR) scanning windows.
   b. Tabulation of installed devices with features and ratings.
   c. Enclosure types and details.
   d. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
   e. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
   f. Current rating of buses.
   g. Short-time and short-circuit current rating of switchgear assembly.
   h. Nameplate legends.
   i. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.


C. Human Machine Interface (HMI) display screenshots for review/approval. Screenshots not specifically tailored to this project will be rejected. Provide the following.
1. Print Screens of the following:
   a. Single line for each unit substation HNA/HNB and LNA/LNB in the Teaching Hospital.

2. Sample reports of the following:
   a. Alarm/trouble report.
   b. Equipment report.
   c. History alarms, troubles, users, and changes.
   d. Alarm frequency report.
   e. Power usage and status report.
   f. Utility status report.

3. Proposed power monitoring network for Owners approval; including components required for a complete system.

4. Software and Firmware Operational Documentation; include the following:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   c. Printout of software application and graphic screens.
   d. For each report type, provide an explanation on how to generate the report and how to change reporting information variables.
   e. User's Manual submittal must be approved prior to Commissioning or Training Demonstrations of the Electrical Monitoring System.

D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
E. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. In addition to items specified in DIVISION 01, Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.05 MAINTENANCE MATERIAL SUBMITTALS:
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
   2. Indicating Lights: Six of each type installed.
   3. Touchup Paint: 3 containers of paint matching enclosure finish, each 0.5 pint.

1.06 QUALITY ASSURANCE:
A. Source Limitations: Obtain switchgear through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING:
A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.08 PROJECT CONDITIONS:
A. Installation Pathway: Coordinate installation of building components and structures to allow pathway for moving switchgear into place and to allow for future removal and/or replacement.

1.09 COORDINATION:
A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete bases are specified in DIVISION 26, Section "Hangers and Supports for Electrical Systems."

PART 2 - PRODUCTS
2.01 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. GE/ABB (Basis of Design – Entellisys).
4. Square D; Schneider Electric.

B. Switchgear shall be compatible with GE Envisage Energy Management System.

2.02 FABRICATION:

A. Factory assembled and tested and complying with IEEE C37.20.1.
B. Indoor Enclosure Material: Steel.
C. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
D. Circuit-breaker compartments shall be fully compartmentalized, equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
E. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
F. Provide hoist rails on top of the switchgear lineup to allow for traveling breaker lifting device.
G. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
   1. Bus transition sections.
   2. Hinged front panels for access to metering, accessory, and blank compartments.
H. Provide separate remote enclosures for Human Machine Interface (HMI) as indicated on Drawings.
I. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
   1. Main Phase Bus: Uniform capacity the entire length of assembly.
   3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
   5. Use copper for connecting circuit-breaker line to copper bus.
   6. Contact Surfaces of Buses: Tin plated.
   8. Ground Bus: Continuous hard-drawn copper of 98% minimum conductivity the entire length of the enclosure, equipped with NEMA 2-bolt bi-metallic long barrel compression terminations compatible with feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
10. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
11. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
J. Provide infrared (IR) scanning windows at each cable termination location.
2.03 COMPONENTS:

   1. Potential Transformers: Secondary-voltage rating of 120V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
      a. Install minimum two (2), fully redundant sets of PT’s per double-ended switchgear lineup.
      b. Leads for external revenue meters shall be located on the line side of the main device.
   2. Current Transformers: Provide Ratios matching trip unit frame size; burden and accuracy class suitable for connected relays, meters, and instruments.
      a. Unless otherwise noted, install CTs matching associated breaker frame ratings for all feeder circuit breaker spare cubicles.
      b. Install dedicated ANSI Accuracy Class current transformers for revenue metering, reference Section 337173.33 ELECTRIC METERS.

B. Control Power Supply: Control power transformer supplying 120V control circuits through secondary disconnect devices. Include the following features:
   1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
   2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
      a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
   4. Fuses are specified in DIVISION 26, Section "Fuses."

C. Human Machine Interface (HMI) shall indicate electrical system oneline diagram, all metering, control, and settings management:
   1. Minimum (1) switchgear touchscreen HMI shall be located in a remote section as shown in the corridor for each switchgear line-up as indicated on the Drawings. Corridor HMIs shall be capable of remote operation of main and tie devices.
   2. Display all metering information specified herein.
   3. Alarm for each type of trip (per phase).
   4. Overload indication.
   5. Display the switchgear one-line, including the open/close status of each main, tie, and feeder circuit breaker, current in amps for each circuit, and phase voltages for each bus.
   6. Display all protection and relay settings for each circuit and incoming line.
   7. User settings menus with the ability to change, enable, or disable protection and relay settings.
   8. USB port for connection of USB devices.
   10. Display of the sequence of events pertinent to the switchgear line-up.
   11. Interface for the control of all devices in the switchgear line-up including touchscreen selectors for:
      a. Automatic transfer and manual mode operation.
      b. Test mode to simulate loss of voltage on the selected main.

D. Trip Unit Metering: Provide networked power monitoring of all main, tie, and feeder circuit breaker trip units. All trip unit metering and status shall visible on the front of the switchgear and be remotely visible at all HMIs. Contractor shall coordinate all required networking cables and hardware to allow for a fully operational monitoring system as specified. Provide all hardware, software, programming, etc necessary for:
1. Demand logging capability
   a. Provide a screen to display the maximum kW demand, kVAR demand, and kVA demand along with date/time stamp, for each breaker.
   b. Write a demand log for each trip unit that contains kWh, kVARh, kW demand, kVAR demand, and power factor. The demand logging interval shall be programmable and capable of being set to an interval as small as 1 minute. Provide the ability to view the log files at each HMI as well as download the log files for off-line storage and analysis.

2. Each trip unit shall locally and remotely display the following (minimum):
   a. Amps per phase, and neutral amperage
   b. Voltage per phase (A-B, B-C, C-A) and phase to neutral voltages (A-N, B-N, C-N)
   c. Real Power (watts), 3 phase total and per phase, and kW demand
   d. Power factor, 3 phase total and per phase.
   e. Energy (watt-hours), both positive and negative as separate quantities, 3 phase total and per phase, and kWh demand
   f. Reactive Energy (kVARh), 3 phase total and per phase, and kVAR demand
   g. Apparent Energy (kVA-hours), 3 phase total and per phase, and kVA demand
   h. Real Power (watts) peak
   i. Breaker trip or close status
   j. Sequence of events log (a minimum of the last 100 events) with 1 millisecond resolution time-stamping. All devices to be synchronized to within 1 millisecond.

3. Data Line Cable: Shielded, twisted-pair cable or other media recommended by manufacturer.

E. Spaces for future circuit breakers are indicated on the Drawings. The spaces shall be bussed completely including connectors, ready to receive breakers without having to install additional bus, parts, or hardware. This provision shall include CTs, control wiring for protective devices, rails and mounting brackets, bus connections and necessary components and hardware. Provisions shall be made for future installation of a new control door and protective device, control switches, indication lights, etc. without entering the switchgear beyond the controls compartment, i.e., all power, monitoring, and control wiring shall be landed and marked on terminal boards, etc., in the controls compartment associated with each future breaker.

1. Control programming shall be complete for these future breaker provisions such that upon future installation, the master controls will not have to be reprogrammed, but that the new breakers may be initialized or activated from the HMI. System one-line diagrams shall anticipate these future breakers initially, such that no additional programming will have to be produced upon installation, other than that necessary to activate the breakers from the HMI.

F. Programmable Controller (Double-Ended Unit Substations):

1. The system shall be controlled by redundant controllers. In the event that one of the controllers fail, the operation shall be backed up by the redundant controller. Controller programming for system operation shall be the responsibility of the switchgear manufacturer.

2. The following shall be provided for programmable control systems:
   a. Password protected register access panel on the breaker cubicle door. This panel shall allow the operator access to the control without having to implement software changes. Handheld control programmer and/or laptop computers to make timer settings are not acceptable.
   b. Extra digital and analog inputs and outputs on each controller. Provide 20% spare inputs and 20% spare outputs.
2.04 SURGE PROTECTION DEVICES:

A. Surge Protection Device: IEEE C62.41-compliant, externally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchgear short-circuit rating, and with the following features and accessories:

1. Accessories:
   a. Fuses rated at 200-kA interrupting capacity.
   b. Fabrication using bolted compression lugs for internal wiring.
   c. Integral disconnect switch.
   d. Redundant suppression circuits.
   e. Redundant replaceable modules.
   f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   g. LED indicator lights for power and protection status.
   h. Audible alarm, with silencing switch, to indicate when protection has failed.
   i. Form-C contacts rated at 5 A and 250Vac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   j. Four-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.

   a. Line to Neutral: 70,000 A.
   b. Line to Ground: 70,000 A.
   c. Neutral to Ground: 50,000 A.

4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277V, three-phase, four-wire circuits shall be as follows:
   b. Line to Ground: 800V for 480Y/277.
   c. Neutral to Ground: 800V for 480Y/277.

2.05 SEQUENCE OF OPERATION FOR DOUBLE-ENDED UNIT SUBSTATIONS:

A. Automatic Transfer Logic:
   1. Automatic transfer scheme shall include a switch for automatic/manual/off operation selection located at the tie circuit breaker.

B. Automatic operation shall ensure that:
   1. Only open transitions can occur.
   2. No non-faulted load shall remain connected to a lost line as long as other incoming lines are not lost.
   3. A line shall be considered lost if voltage on any phase falls below 70% of nominal for an adjustable 0.2s to 60s, factory preset to 5s; or below 90% of nominal for an adjustable 0.2s to 180s, factory preset to 15s.
   4. No transfer shall occur into a detected fault.
   5. Retransfer to normal state shall occur automatically when de-energized Line A has been re-energized to 90% or more of nominal voltage for an adjustable 0.2s to 180s, factory preset to 20s; except retransfer shall be immediate if Line B is lost and Line A has been re-energized to 90% or more of nominal voltage. Operation shall be similar if Line B is lost and Line A remains active. A time delay (adjustable from 0.5s to 10s) shall be
provided so that voltage on the dead bus decays to 20% nominal or less before reclosure of the dead bus to the live bus.

7. Provide an indicator light to indicate the failed source is available and the system is attempting to retransfer to normal. The light shall extinguish on selection of "manual" mode or on retransfer.

C. Manual operation shall ensure that:
   1. Automatic re-transfer functions are voided.
   2. Manual breaker control push buttons are operable.

D. When selector switch is in Off position, breakers shall be inoperative manually and automatic transfer functions shall be voided. All protective functions shall remain functional during all modes of operation.
   1. Should the selected source become unavailable, the system will remain as-is and shall require operator interface to transfer to a non-selected source via the manual operation specified above.

E. Main-Tie-Main Interlock:
   1. Interlock main-tie-main breakers to trip and close circuits such that in manual and automatic operation only 2 of 3 breakers can be closed at a time.

F. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
   1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   2. Conductors sized according to NFPA 70 for duty required.

2.06 CIRCUIT BREAKERS:

A. Anything with a trip function shall have trip indication visible on the front of the switchgear without the opening of any doors or covers.

B. Description: Comply with IEEE C37.13.

C. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

D. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   1. Normal Closing Speed: Independent of both control and operator.
   2. Slow Closing Speed: Optional with operator for inspection and adjustment.
   4. Operation counter.

E. Control power shall not be required for breaker to trip.

F. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
   1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
   2. Temperature Compensation: Ensures accuracy and calibration stability from -5 to +40ºC.
   3. Field-adjustable, time-current characteristics.
   4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
   5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
   7. Pickup Points: Five minimum, for instantaneous-trip functions.
8. **Ground Fault Protection:**
   a. Provide modified differential ground fault protection scheme for Main-Tie-Main circuit breakers.
   b. Main devices shall be equipped with a ground fault protection system, including control power source.
   c. Feeder devices shall be equipped with ground fault protection systems coordinated with that of the main device.
   d. Ground fault protection shall be fully selective such that the feeder device and not the service device shall open on ground faults on the load side of the feeder device. A 6 cycle minimum separation between the service and feeder ground fault tripping bands shall be provided. Operating time of the disconnecting devices shall be considered in selecting the time spread between these 2 bands to achieve 100% selectivity.

9. **Trip Indication:** Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault. Indication shall be visible on the front of the switchgear without opening of any doors or covers.

10. **Energy-reducing maintenance switch with strobe/light indication and HMI alarm.**

G. **Auxiliary Contacts:** For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

H. **Drawout Features:** Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
   1. **Interlocks:** Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
   2. **Circuit-Breaker Positioning:** An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
      a. **Test Position:** Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
      b. **Disconnected Position:** Primary and secondary devices and ground contact disengaged.

I. **Padlocking Provisions:** For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism. Shall be padlockable in the open and racked out position.

J. **Electric Close Button:** One for each electrically operated circuit breaker.

K. **Shunt-Trip Devices:** Where indicated.

L. **Indicating Lights:** To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.07 **ACCESSORIES:**

A. **Accessory Set:** Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
   1. Racking handle to manually move circuit breaker between connected and disconnected positions.

C. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

D. Provide two (2) remote racking mechanisms. This will allow the operator to rack a breaker in/out up to 30 feet away from the front of the equipment.

E. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.08 IDENTIFICATION:

A. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
   1. Frame size of each circuit breaker.
   2. Trip rating for each circuit breaker.
   3. Conduit and wire size for each feeder.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Comply with applicable portions of NECA 400 and NEMA PB 2.1.
B. Install low-voltage switchgear on concrete bases.
   1. Anchor low-voltage switchgear to concrete bases according to manufacturer's written instructions and requirements in DIVISION 26, Section "Hangers and Supports for Electrical Systems."
C. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A-486B.
D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.03 IDENTIFICATION:

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in DIVISION 26, Section "Electrical Identification."
B. Diagram and Instructions:
   1. Operating Instructions: Printed basic instructions for switchgear, including control sequences and emergency procedures.
C. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.04 CONNECTIONS:
A. Ground equipment according to DIVISION 26, Section "Grounding."
B. Connect wiring according to DIVISION 26, Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL:
A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect switchgear installation, including wiring, components, connections, and equipment.
   2. Complete installation and startup checks according to manufacturer's written instructions. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
   4. The manufacturer's representatives shall be on site for system switchgear energization, commissioning, functional, and integrated testing as defined by Commissioning sections of these specifications.
C. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear lineup.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear lineup 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 GROUNDING:
A. Provide equipment grounding connections for switchgears as indicated. Tighten connections to comply with tightening torques specified in UL 486A-486B to assure permanent and effective grounding.

3.07 ADJUSTING:
A. Set field-adjustable overcurrent device trip characteristics as directed by Engineer.
3.08 CLEANING:
   A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.09 PROTECTION:
   A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturers stipulated service conditions.

3.010 DEMONSTRATION:
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.
      1. Train Owners management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Train them in troubleshooting, servicing, adjusting, and maintaining equipment.
      2. Training Aid: Use the approved final versions of software and maintenance manuals as training aids.
      3. Train Owners management in logging capabilities and how to download and export data.

3.011 ON-SITE ASSISTANCE:
   A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION 262300
262726 - WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:

A. SECTION Includes:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Hospital-grade receptacles.
   3. Snap switches and wall-box dimmers.
   4. Wall-switch.

1.03 DEFINITIONS:

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
D. RFI: Radio-frequency interference.

1.04 REQUIREMENTS:

A. Coordination:
   1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

1.05 REFERENCE STANDARDS:

A. National Electrical Manufacturers Association (NEMA):
   1. FB-11-83: Plugs, Receptacles and Connectors of the Pin and Sleeve Type for Hazardous Locations.
   2. PR 2-86: Enclosures for Plugs, Receptacles and Connectors of the Pin and Sleeve Type.
   4. WD-1: General Requirement for Wiring Devices.
   5. WD-2: Wiring Devices - Dimensional Requirements.

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Underwriters Laboratories (UL):
   1. 20 - General Use Snap Switches.
   2. 498 - Electrical Attachment Plugs and Receptacles.
   3. 544 - Electrical Medical and Dental Equipment.
   4. 943 - Ground-Fault Circuit Interrupters.
   5. 1010 - Receptacle-Plug Combinations for use in Hazardous (Classified) Locations.
   6. 486A-486B - Wire Connectors.
1.06 SUBMITTALS:
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS:
A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.
C. Receptacles connected to normal power shall be white.
D. Receptacles connected to emergency power shall be red in color.

2.03 STRAIGHT-BLADE RECEPTACLES:
A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

2.04 GFCI RECEPTACLES:
A. General Description:
   1. Straight blade, non-feed-through type.
   2. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
   3. Provide GFCI receptacle capable of self-testing.
B. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

2.05 TOGGLE SWITCHES:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
SECTION 262726 – WIRING DEVICES:  continued

B. Comply with NEMA WD 1, UL 20, and FS W-S-896.
C. Heavy duty grade, quiet type.
D. Switches, 120/277 V, 20 A:
   2. Two Pole.
   3. Three Way.
   4. Four Way.

2.06 WALL PLATES:

A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.
   5. Devices on Emergency Power: Brushed stainless steel with circuiting information engraved in red on face of wall plate.

2.07 FINISHES:

A. Device Color:
   1. Wiring Devices Connected to Normal Power System: Gray, to match existing, unless otherwise indicated or required by NFPA 70 or device listing.
B. Wall Plate Material: Smooth, brushed stainless steel

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.
C. Conductors:
   1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtales.
D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When branch circuit conductors are larger than recommended by device manufacturer for termination, the use of splice pigtails is allowed.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in all areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.02 GFCI RECEPTACLES:

A. Install non-feed-through-type GFCI receptacles for locations within 6 feet of sinks, toilets, and as indicated on drawings.

3.03 IDENTIFICATION:

A. Comply with SECTION 260553 – ELECTRICAL IDENTIFICATION.
B. Identify each receptacle and light switch wall plate with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face or plate for devices connected to normal power and red-filled lettering on face of plate for devices connected to emergency power with brushed stainless wall plate, and durable wire markers or tags inside outlet boxes.

3.04 FIELD QUALITY CONTROL:

A. Test wiring devices for proper polarity, ground continuity, and compliance with requirements.
B. Test GFCI operation with device mounted pushbutton.
C. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION 262726
PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:
A. SECTION Includes:
1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.

1.03 REFERENCE STANDARDS:
A. Applicable Standards: Comply with applicable requirements of following standards.
1. American National Standards Institute (ANSI):
   a. C97.1 - Low-Voltage Cartridge Fuses 600V or Less.
2. National Electrical Manufacturer's Association (NEMA):
   a. FU1 - Low-Voltage Cartridge Fuses.
   a. 70 - National Electrical Code (NEC). Comply with NEC as applicable to construction and installation of fusible devices.
4. Underwriters Laboratories (UL): Provide overcurrent protective devices which are UL-listed and labeled.
   a. 198C - High-Interrupting-Capacity-Limiting Type Fuses.
   b. 198E - Class R Fuses.
   c. 198G - Fuses for Supplementary Overcurrent Protection.
   d. 198L - DC Fuses for Industrial Use.

1.04 SUBMITTALS:
A. Product Data: For each type of product indicated. Include construction details, material, dimensions, and descriptions of individual components. Include the following for each fuse type indicated:
1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for disconnect switches.
1.05 QUALITY ASSURANCE:
   A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   C. Comply with NEMA FU 1 for cartridge fuses.
   D. Comply with NFPA 70.
   E. Comply with UL 248-11 for plug fuses.

1.06 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.

1.07 COORDINATION:
   A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Cooper Bussmann, Inc.
      2. Edison Fuse, Inc.
      3. Ferraz Shawmut, Inc.
      4. Littelfuse, Inc.

2.02 CARTRIDGE FUSES:
   A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 PLUG FUSES:
   A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.04 PLUG-FUSE ADAPTERS:
   A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS:

A. For applications less than or equal to 600A: Class RK1 Current-Limiting and Time-Delay Fuses.
   1. UL Class RK1 time-delay fuses rated 250 or 600 volts (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting motors, transformers, and circuit breakers.

B. For applications less than or equal to 600A: Class J Fast-Acting Current-Limiting Fuses.
   1. UL Class J current-limiting fuses rated 600 volts, 60 hertz, amperes as indicated with 200,000 RMS amperes symmetrical interrupting current rating.

C. For applications less than or equal to 600A: Class RK5 Current-Limiting and Time-Delay Fuses:
   1. UL Class RK5 time-delay fuses rated 250 or 600 volts (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting motors.

3.03 INSTALLATION:

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

3.04 IDENTIFICATION:

A. Install labels complying with requirements for identification specified in SECTION 260553 ELECTRICAL IDENTIFICATION and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813
262816 - CIRCUIT AND MOTOR DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:
   A. SECTION Includes:
      1. Fusible switches.
      2. Non-fusible switches.
      3. Molded-case circuit breakers (MCCBs).
      5. Enclosures.

1.03 RELATED REQUIREMENTS:
   A. SECTION 260553 - ELECTRICAL IDENTIFICATION.
   B. SECTION 262726 - WIRING DEVICES for manual switches used as motor disconnects.
   C. SECTION 262813 - FUSES.

1.04 REFERENCE STANDARDS:
   A. National Electrical Manufacturers Association (NEMA):
      1. 250 - Enclosures for Electrical Equipment (1,000V maximum).
      2. KS 1 - Enclosed Switches.
   B. National Fire Protection Association (NFPA):
      1. 70 - National Electrical Code (NEC).
   C. Underwriters Laboratories (UL):
      1. 98 - Enclosed and Dead-Front Switches.
      2. 869 - Electrical Service Equipment.
      3. 894 - Switches for Use in Hazardous (Classified) Locations.
      4. 977 - Fused Power-Circuit Devices.

1.05 DEFINITIONS:
   A. NC: Normally closed.
   B. NO: Normally open.
   C. SPDT: Single pole, double throw.

1.06 SUBMITTALS:
   A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
      1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.07 QUALITY ASSURANCE:
A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Comply with NFPA 70.

1.08 PROJECT CONDITIONS:
A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22°F and not exceeding 104°F.
   2. Altitude: Not exceeding 6600 feet.
B. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

1.09 COORDINATION:
A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 FUSIBLE AND NONFUSIBLE SWITCHES:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. ABB / GE.
   3. Square D; a brand of Schneider Electric.
B. Type HD, Heavy Duty, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
      a. Provide where ground conductors are indicated in the circuit.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
      a. Provide where neutral conductors are indicated in the circuit.
   3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), 120 V, 15 A rating, arranged to activate before switch blades open.
      a. Where installed between variable frequency drives and motors, provide electrical interlock kits to break the control circuit before the main switch blades open.
   4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   5. Hookstick Handle: Allows use of a hookstick to operate the handle.
   6. Lugs: Mechanical type, suitable for number, size, and conductor material.

D. Nonfusible type for motor loads 1 hp or smaller or nonmotor loads connected to a 20 A or smaller circuit may be toggle type switches, UL listed for each specific type load.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
      b. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

2.04 ENCLOSURES:
   A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
      1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
      2. Outdoor Locations: NEMA 250, Type 3R.
      3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
      4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.
B. Comply with mounting and anchoring requirements specified in SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS and SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.

C. Disconnects shall be installed where specified herein, indicated on the Drawings, or required by manufacturer's written instructions.

D. Install combination disconnect/motor starters furnished under other Divisions.

E. Provide control wiring for electrical interlocks between drives and variable frequency motor disconnect switches.

F. Coordinate disconnect installation with raceways, wiring, and equipment.

3.03 LOCATION:

A. Coordinate location of disconnects with equipment being controlled.

B. When used as disconnecting means, locate as near as practicable to the load controlled.

C. Disconnects provided integral with equipment shall serve as disconnecting means where allowed by NFPA 70.

D. When used for branch circuit protection, disconnects shall be located as near as practicable to the supply end of the conductors being protected.

E. Disconnects used with motor-driven appliances, or motors and controllers shall be located within sight of controller, unless indicated otherwise on the Drawings.

F. Disconnects shall be installed in accessible locations.

3.04 FUSIBLE DISCONNECTS:

A. Fusible disconnects shall not be mounted in ceiling plenums.

B. Fuses shall be installed in fusible disconnects as specified in SECTION 262813 - FUSES.

3.05 IDENTIFICATION:

A. Comply with requirements in SECTION 260553 – ELECTRICAL IDENTIFICATION.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved laminated-plastic nameplate.

3.06 ADJUSTING:

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 262816
PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:

A. SECTION Includes:
   1. Lighting fixtures.
   2. Exit signs.
   3. Lighting fixture supports.

B. Related SECTIONS:
   1. SECTION 262726 – WIRING DEVICES

1.03 REFERENCES:

A. Applicable Standards: Comply with applicable requirements of the following standards.
   1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
   2. National Electrical Manufacturers Association (NEMA):
      a. 70 - National Electrical Code (NEC). Comply with applicable local code requirements of the authority having jurisdiction and the NEC.
   4. Underwriters Laboratories (UL): Provide interior lighting fixtures and components which are UL-listed and labeled.
      a. 57 - Electric Lighting Fixtures.
      b. 486A-486B - Wire Connectors.
      c. 924 – Standard for Emergency Lighting and Power Equipment.

1.04 DEFINITIONS:

A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. LER: Luminaire efficacy rating.
D. Lumen: Measured output of lamp and luminaire, or both.
E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.05 SUBMITTALS:

A. Product Data:
   1. For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
      a. Physical description of lighting fixture including dimensions.
      b. Energy-efficiency data.
c. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
d. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type.

2. Lighting Inverter: Include data on features, accessories, finishes.

B. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in DIVISION 01 include the following:

1.06 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.

1.07 COORDINATION:

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, fire alarm system, and partition assemblies.

1.08 WARRANTY:

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Products: Subject to compliance with requirements, provide products indicated on Drawings or Owner approved equal.

2.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires and lighting equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.03 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS:

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
B. Metal Parts: Free of burrs and sharp corners and edges.
C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally when secured in operating position.
E. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100% virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
   b. UV stabilized.

2.04 LED DRIVERS:
A. LED drivers shall meet the following requirements:
   1. Drivers shall have a minimum efficiency of 85%
   2. Starting Temperature: -40 degrees F.
   3. Input Voltage: 120 to 277V (plus or minus 10%)
   4. Power supplies: Class I or II output.
   5. Power Factor (PF): greater than or equal to 0.90.
   6. Total Harmonic Distortion (THD): Less than or equal to 20%.
   8. Drivers shall be reduction of hazardous substances (ROHS) compliant.
   9. 0-10V continuous dimming capability with a range of 10% to 100%. Provide 1% to 100% dimming capability where shown on drawings.

2.05 EXIT SIGNS:
A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
C. Exit signs shall be connected to unswitched emergency power.

2.06 LED SOURCES
A. LED light sources shall meet the following requirements:
   1. Operating temperature rating shall be between -40 degrees F to 120 degrees F.
   2. Correlated Color Temperature (CCT): 4000K or as scheduled.
   3. Color Rendering Index (CRI): greater than or equal to 80.
   4. Average rated life of 50,000 hours at 70% lumen output (L70).

2.07 LIGHTING FIXTURE SUPPORT COMPONENTS:
A. Comply with SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for channel- and angle-iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
E. Chain: Heavy duty type, provided with light fixture.
F. Wires for Humid Spaces: ASTM A580/A580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
2.08 LIGHTING INVERTER

A. Inverter Performance Requirements:
1. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 2 milli-second or less from normal supply to battery-inverter supply.
   a. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.

B. Inverters:
1. Description: Solid-state type, with the following operational features:
   a. Automatically regulate output voltage to within ±5%.
   b. Automatically regulate output frequency to within ±1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
   c. Output Voltage Waveform of Unit: Sine wave with maximum 3% THD for linear loads throughout battery operating-voltage range, from no load to full load.
3. Overload Capability: 115% for 10 minutes; 150% surge.

C. Battery Charger:
1. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

D. Batteries:
1. Description: Standard, sealed, valve-regulated, recombinant, lead-calcium batteries.
   a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

E. Enclosures:
1. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.

F. Control and Indication:
1. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.
2. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
3. Indications: Plain-language messages on a digital LCD or LED panel.
   a. Quantitative Indications:
      1) Input voltage.
      2) Input current.
      3) System output voltage.
      4) System output current.
      5) System output frequency.
      6) Battery voltage.
      7) Battery current.
      8) Elapsed time-discharging battery.
b. Basic Status Condition Indications:
   1) Normal operation.
   2) Load-on bypass.
   3) Load-on battery.
   4) Inverter off.
   5) Alarm condition exists.

c. Alarm Indications:
   1) High battery charger voltage.
   2) Charger fault.
   3) Overload.
   4) Nearing low battery voltage.
   5) Input overvoltage or undervoltage.
   6) Battery undervoltage shutdown.
   7) Ambient overtemperature.
   8) Inverter fault.
   9) Inverter output overload.
  10) Inverter output overload shutdown.

d. Controls:
   1) Inverter on-off.
   2) Start.
   3) Battery test.
   4) Alarm silence/reset.
   5) Output-voltage adjustment.

4. Dry-form "C" contacts shall be available for remote indication of the following conditions:
   a. Inverter on battery.
   b. Inverter on-line.
   c. Inverter load-on bypass.
   d. Inverter in alarm condition.
   e. Inverter off (maintenance bypass closed).

5. Include the following minimum array:
   a. Ready, normal-power on light.
   b. Charge light.
   c. Inverter supply load light.
   d. Battery voltmeter.
   e. AC output voltmeter with minimum accuracy of 2% of full scale.
   f. Load ammeter.
   g. Test switch to simulate ac failure.

G. Enclosure: Steel, with hinged lockable doors, suitable for wall mounting. Manufacturer's standard corrosion-resistant finish.

H. Internal Maintenance Bypass Switch: Load is supplied, bypassing central battery inverter system.

I. NFPA 101 self-testing and data logging.
   1. Keypad on device front panel provides access to monitored data using front panel display.
   2. Memory device to store recorded data in nonvolatile electronic memory.
   3. RS-232 port to permit downloading of data to a portable personal computer.
   4. Modem to make measurements and recorded data accessible to remote personal computer via telephone line. Computer will be provided by Owner.

J. Forced air cooling only during emergency operation with no filters required.

K. Emergency generator compatible.
SECTION 265100 - LIGHTING: continued

L. Single input with multiple output circuit breakers as indicated on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

B. Temporary Lighting: If it is necessary, and approved by Owner, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Install two independent support rods or wires from structure to a tab on opposing corners of lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Connect wiring according to SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

F. Ensure all moisture and debris have been removed from in-grade light fixtures prior to installation. Seal conduit entries at exterior and in-grade light fixtures to prevent infiltration of moisture, debris and insects.

3.02 IDENTIFICATION:

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in SECTION 260553 - ELECTRICAL IDENTIFICATION.

3.03 FIELD QUALITY CONTROL:

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 265100
SECTION 337149 – MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.03 DEFINITIONS:

A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
C. Sheath: A continuous metallic covering for conductors or cables.

1.04 SUBMITTALS:

A. Product Data: For each type of cable, include splices and terminations for cables and cable accessories.
B. Qualification Data: For Installer.
C. Material Certificates: For each type of cable and accessory.
D. Source quality-control reports.
E. Field quality-control reports.

1.05 QUALITY ASSURANCE:

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
   1. The Contractor shall submit proof that each cable splicer has had at least 3 years experience in splicing EPR cables rated in the 15 kV voltage class. This proof is required before any splicing may proceed and shall consist of at least 3 references with contact names and telephone numbers.
B. Testing Agency Qualifications:
   1. The service and testing company shall be one which has been in the business of testing medium voltage cables for at least 3 years, and shall not be a part of any business entity responsible for the supply and installing medium voltage cable under this contract. Test results shall be certified by a NETA Level 3 or 4 Technician employed by the testing company. The Technician shall interpret the results and shall sign each test report. Test equipment used shall have been calibrated within the 12 month period immediately preceding the test date. Certification of calibration within this time period is required and shall be furnished with the test reports. Test reports furnished without this certification or tests made with equipment without the required certification are invalid and will not be accepted.
PART 2 – PRODUCTS:

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cables (no substitutions are allowed):
      a. Kerite; a Marmon Wire & Cable/Berkshire Hathaway company.
      b. Okonite Company (The).
   2. Cable Splicing and Terminating Products and Accessories (no substitutions are allowed):
      a. 3M; Electrical Markets Division.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.02 SYSTEM DESCRIPTION:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

2.03 CABLES:

A. Cable Type: MV105

B. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.

C. Conductor: Annealed, uncoated copper compact stranded ASTM B-469.

D. Strand Screen: Extruded semiconducting EPR.

E. Insulation: 15kV insulated with 100% Ethylene Propylene Rubber (EPR) for 133 percent insulation level, 220 mils average thickness (198 mils minimum). The insulation shall not contain any polyethylene.

F. Insulation Screen: Extruded semiconducting EPR. The screen shall not contain any polyethylene.

G. Shield: Shield shall be overlapped 5 mil bare copper tape, helically applied.

H. Jacket: Jacket thickness shall not be less than 80 mils of black polyvinyl chloride.

I. Temperature Ratings: 
   1. Wet or dry normal rating – 105 deg C
   2. Emergency rating – 140 deg C
   3. Short circuit rating – 250 deg C

J. The cable must be flat line corona tested with less than 5 picocoulombs by manufacturer. Cable shall meet the requirements of AEIC CS6, ICEA S 68-516, and UL1072

2.04 TERMINATIONS:

A. Terminations shall be outdoor type cold shrink silicone rubber skirted termination kit as manufactured by 3M.

2.05 SPLICE KITS:

A. Splices shall be in-line cold shrink type QS-III or QS-4 as manufactured by 3M.

2.06 FIRE TAPE:

A. Fire tape shall be 3-inch-wide Scotch 77 Fire-Retardant electric Arc Proofing Tape manufactured by 3M.
PART 3 – EXECUTION

3.01 CABLE HANDLING:

A. Medium voltage cables shall be handled as specified herein and in accordance with the manufacturer's instructions. Where similar work is addressed by the manufacturer's instructions and in these requirements, the more stringent requirement shall apply.

B. Reels shall be shipped upright and stored upright in locations where the flanges will not sink or otherwise allow weight to rest on the cable's surface. Reels shall not be laid on sides.

C. Reels shall be lifted by a shaft through the arbor holes or by cradles or forks oriented perpendicular to the flanges and contacting both flanges. Under no circumstances may any lifting device be allowed to contact cable surfaces.

D. Where reels are rolled, secure cables and roll in direction to prevent loosening of cables on reels. Apply force only to reel flanges.

E. Exercise care in all phases of cable handling and installation to prevent deformation, abrasion, and other damaging effects.

F. Medium voltage cables shall not be bent sharper than the manufacturer's recommended minimum bending radius at any time. Cable shall not be bent sharper than the greater of the manufacturer's recommendation or 12 times the cable outside diameter. Care shall be exercised to prevent damage to the cable sheath, conductor or insulation due to nicking, excess pulling tension, or deformation. Where cables are bent at a smaller radius than that specified, the affected cables shall be replaced by the Contractor at no additional expense to the Owner.

G. Where cables are to be pulled through manholes or enclosures, sheaves of suitable radius shall be used to prevent bending the cables sharper than the minimum specified by the cable manufacturer. Conveyor sheave assemblies having at least one roller for each 20º of bend are acceptable.

H. Medium voltage cables shall be pulled with manufactured cable pulling eyes attached to the conductors. Basket grips and rope hitches for pulling attachment shall not be used. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
   2. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
   3. Do not pull cables with ends unsealed. Seal cable ends as specified.

I. Where mishandling occurs or where evidence of mishandling is found, the affected cables shall be replaced by the Contractor at no additional expense to the Owner. Any cables not handled in accordance with these specifications and the referenced documents shall be considered to be mishandled.

J. Medium voltage cables shall be inspected on receipt for the presence of moisture. Cables found to contain moisture shall be replaced. Install cable end seals immediately on receipt of dry cable.

K. Medium voltage cables shall be protected from the entrance of moisture during pulling operations.

L. Install cable end seals immediately following any cutting or pulling operation.

M. System Owner shall be notified of any damage to evaluate repair or replacement requirements.

3.02 INSTALLATION:

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Install cables in conduit parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Install cables so that splices are minimized.

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

F. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

G. Install terminations at ends of conductors.

H. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
   1. Clean cable sheath.
   2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
   3. Smooth surface contours with electrical insulation putty.
   4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
   5. Band arc-proofing tape with two layers of 1-inch wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

I. Seal around cables passing through fire-rated elements.

J. All cable splices shall be grounded and sealed.

K. Cable shields shall be grounded at each termination through the use of termination kits using manufacturer's recommended fittings, materials, grounding conductors, etc. Provide ground lugs in equipment and make connections to grounding. In switchgear, make connections to ground bus. In manholes, make connections to grounding conductor around inside perimeter of each manhole.

L. Identify cables as described below at equipment with non-metallic UV resistant tags and non-conductive cable ties. Lettering shall be 3/8” minimum, permanent, machine printed and black in color. Identify phase and circuit number of each conductor at each splice, termination; pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification. Feeders shall be labeled similar to:

   15 kV
   Feeder  704A
   From MIDWAY 13.8KV
   To USS-LNA
   Supplying TEACHING HOSPITAL

Submit identification schedule for approval prior to labeling cables.

M. Phase markers shall be installed at each splice and termination consistent with existing markers at the Campus. Phase orientation at equipment shall match the existing.

N. Equip unused terminations and connections with waterproof dead-end covers.

O. Each termination or splice shall be inspected by System Owner personnel prior to the installation of the outer covering.

3.04 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
1. Factory testing:
   a. The cable manufacturer shall perform nondestructive factory tests on cable in accordance with ICEA standards.
   b. All factory certified tests shall be included as part of the conductor submittal.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
3. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
4. Field testing:
   a. A certified third party testing firm shall perform the DC high potential testing.
   b. High potential tests shall be performed as specified below:
      (1) All new conductors shall be tested after it has been pulled into the duct and the splice or termination has been prepared but before the shrink tubing has been installed.
      (2) The test voltage for the newly installed conductors shall be 60 kV, and the voltage shall be maintained for 15 minutes, with data taken at 1-minute intervals. Written report shall be delivered to owner including all data and results or conclusions.
      (3) Cable is to be grounded for 30 minutes after test.
      (4) Adequate means shall be taken to ensure safety during the tests and safety instructions of the test operator shall be carried out.
      (5) If a cable fails, the fault shall be located, and all cables in that conduit shall be withdrawn and shall be replaced by new cable. After the replacement of the faulted cable the circuit shall be retested.
      (6) During the period of warranty any failure in primary cable, terminations or splices shall require immediate correction. In the event of a failure creating interruption in electrical service, furnish and install labor and materials for temporary services to get the electrical system back in service. Work shall begin immediately upon notification of a failure, regardless of time.
   c. Perform Insulation Ground Wall Test at 5 kV DC after all splices and terminations have been completed. Written report of result of test with resistance values shall be delivered to system owner.
   d. Submit certified test results of each test on the feeder conductor installed with operations and maintenance manuals.
C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
D. All in service switchgear shall be operated by System Owner personnel only.
E. All splices, terminations, testing, grounding, and fire taping shall be completed prior to System Owner personnel energizing the cable.
SECTION 337173.33 - ELECTRIC METERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. This Section includes equipment for electricity metering.

1.03 REFERENCED STANDARDS:

A. National Electrical Contractors Association (NECA).
   1. 1 – Standard Practice of Good Workmanship in Electrical Construction.
   2. 400 – Installing and Maintaining Switchboards.
B. National Electrical Manufacturers Association (NEMA).
   1. 250 – Enclosures for Electrical Equipment (1000V Maximum).
C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
D. Underwriters Laboratories (UL).
   1. UL 1244 – Electrical or Electronic Measuring or Testing Equipment.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Shop Drawings: For electricity-metering equipment.
   1. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designs to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.05 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.01 METER:

A. The kWH meter shall be Solid-State Polyphase Meter.
B. Type: Class 20, service Wye, wires 4, test amp 2.5, form 9S, standard nameplate.
C. Meters will be furnished by System Owner.

2.02 CURRENT TRANSFORMERS:

B. Current transformers (CT’s) shall be of a design for indoor use suitable for electricity metering grade. The CT’s shall be suitable for switchgear installation. The current transformer body construction shall be of molded insulation. The preferred outside body shape or configuration shall be Grecian Urn style. The CT’s shall be window-type with voltage application range of 1.2 to 15kV.

C. The combination of ratio and rating factor (RF) of selected CT’s shall be chosen to pick up a small load. At service full load, meter current must not exceed 20 amperes or the CT’s maximum rating whichever is smaller. Service full load shall be determined from the smaller of either the transformer secondary full load amps or the main service protective device. CT ration and RF rating shall be chosen from the following table:

<table>
<thead>
<tr>
<th>Service Full Load(s)</th>
<th>CT Ratio (CTR)</th>
<th>Minimum Rating Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2250A&lt;S≤3000A</td>
<td>3000:5</td>
<td>1 @ 55°C Ambient</td>
</tr>
<tr>
<td>3900A&lt;S≤4200A</td>
<td>4000:5</td>
<td>1 @ 85°C Ambient</td>
</tr>
</tbody>
</table>

D. ANSI Accuracy Class, 60Hz.

E. B0.2 Burdens per ANSI.

F. Polarity permanently molded primary H1/H2 and secondary X1/X2.

G. Stainless steel Name Plate shall carry all information prescribed by the ANSI standard and installed at easy to read location.

2.03 WIRING

A. All secondary current circuit wiring shall be of pvc insulated, flexible, multi-stranded and colored (red, yellow, blue, white) wire with appropriate gauge as shown in the table, in section 3.01 below.

B. All potential wiring shall be #12 AWG pvc insulated, solid stranded and colored (red, yellow, blue, white) wires.

2.04 METER BASE (SOCKET)

A. The Meter Sockets shall conform to ANSI Standard C12.7-1993.

B. The acceptable meter sockets are:

1. Transformer rated, 20A, Milbank #UC7445-XL pre-wired with test switch or equal.

2.05 FUSE BLOCKS

A. Cooper Industries, Bussman Fuse Block #BMM603-3SQ, 30A, 600V.

2.06 FUSE

A. Cooper/Bussmann KTK-2.

B. Cooper/Bussmann KTK-15.
PART 3 - EXECUTION

3.01 INSTALLATION:

A. The installation of energy meter shall be according to NEC, ANSI and IEEE C12 Electricity Metering standards, where applicable.

B. The Contractor shall supply and install current transformers, fuse block and fuses, meter socket, conduits, prescribed wires and other material and gadgets required to complete the job.

C. Meter Wiring:
   1. The maximum distance in feet between CT and meter shall meet ANSI accuracy classification at B0.2 accuracy class.

<table>
<thead>
<tr>
<th>AWG Copper Wire Size</th>
<th>NO. 12 multi-stranded</th>
<th>NO. 10 multi-stranded</th>
<th>NO. 8 multi-stranded</th>
<th>NO. 6 multi-stranded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Distance (in feet)</td>
<td>31</td>
<td>49</td>
<td>79</td>
<td>126</td>
</tr>
</tbody>
</table>

   2. System Owner shall terminate all wires at the current transformers, fuse block, and the meter.

   3. Reference wiring detail shown on Drawings.

D. Meter Location:
   1. The final location of the meter shall be coordinated with System Owner. Meter shall be installed in accessible location not more than 5.5’ high.

3.02 FIELD QUALITY CONTROL:

A. After the new installation is energized for the first time, the System Owner shall perform an “in service” test in the presence of the contractor or his representative. All deficiencies other than the meter shall be corrected by the Contractor.

B. The meter shall be programmed and inserted into socket by System Owner personnel.

END OF SECTION 337173.33