CAMPUS FACILITIES

General Services Bldg.
Columbia, Missouri 65211
Telephone: (573) 882-6800

ADVERTISEMENT FOR BIDS

Sealed bids for:

EAST CAMPUS CHILLER PLANT –
INSTALL WATER COOLED CHILLER
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
PROJECT NUMBER: CP212233 CONSTRUCTION ESTIMATE: $834,305.34 - $927,005.93

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., September 22, 2022 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 Randy Diemer with Ross & Baruzzini at (314) 391-5779 or rdiemer@rossbar.com. Questions regarding commercial conditions should be directed to Ashley Karpel at (573) 882-1349 or karpela@missouri.edu.

A prebid meeting will be held at 10:00 a.m., C.T., September 14, 2022 in the General Services Bldg., Room 194A, followed by a site walk-through.

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, 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: September 1, 2022

PROJECT MANUAL FOR: EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER

PROJECT NUMBER: CP212233

AT
UNIVERSITY OF MISSOURI
Columbia, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

ROSS & BARUZZINI, INC.
6 SOUTH OLD ORCHARD
ST. LOUIS, MISSOURI 63119
1 (800) 404-7677 (PHONE)
1 (314) 918-1766 (FAX)

DATE: AUGUST 25, 2022

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Mechanical and Plumbing Engineer

Ross & Baruzzini, Inc.
6 South Old Orchard
St. Louis, Missouri 63119
Phone: 1 (800) 404-7677

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

Section 031000, Section 031550, Section 032000, Section 033000, Section 099000, Section 220100. Section 220500, Section 221316, Section 221319, Section 230100, Section 230500, Section 230513, Section 230519, Section 230523, Section 230529, Section 230540, Section 230700, Section 230900, Section 230990, Section 232113, Section 232123, and Section 236416.

Signature: _____ Date: 08/25/2022

Randy Diemer – MO License No.: PE-2017015702

Electrical Engineer

Ross & Baruzzini, Inc.
6 South Old Orchard
St. Louis, Missouri 63119
Phone: 1 (800) 404-7677

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

Section 260500, Section 260519, Section 260526, Section 260529, Section 260533, Section 260534, Section 260536, Section 260553, Section 260600, Section 260913, Section 262413, Section 262813, and Section 262923.

Signature: _____ Date: 08/25/2022

Gary N. Fischer – MO License No.: PE-2018021177

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PROJECT MANUAL FOR: EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER

PROJECT NUMBER: CP212233

TABLE OF CONTENTS

END OF SECTION

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 Assistant Vice Chancellor – Facilities
Room L100 General Services Building
University of Missouri – Columbia
Columbia, Missouri 65211

1. Bidder, in compliance with invitation for bids for construction work in accordance with Drawings and Specifications prepared by Ross & Baruzzini, entitled "EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER", project number CP212233 dated August 8, 2022 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 install a new water cooled centrifugal chiller (Owner-furnished), pump, associated piping, conduit, controls, supports, auxiliary equipment, electrical gear, and electrical switch (Owner-furnished); all as indicated on the Drawings and described in these Specifications for sum of:

   _____
   _____DOLLARS ($_____).

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 by June 1st, 2023 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.

d. Special scheduling requirements:

1. All shutdowns to the chilled water system must be coordinated with Owner's Representative.
2. All shutdowns to the electrical system must be coordinated with Owner's Representative.
3. All outages to existing utilities shall be scheduled with the Owner's Representative a minimum of 72 hours in advance of the outage.
4. Owner purchased water cooled chiller will be delivered to East Campus Chiller Plant. Contractor shall take possession of chiller and install per the Contract Documents. Anticipated delivery date of chiller is January 20, 2023.
5. Owner purchased electrical switchboard, variable frequency drive for the new pump and two disconnects will be delivered to East Campus Chiller Plant. Contractor shall take possession of electrical switchboard and two disconnects and install per the Contract Documents.
   a. Anticipated delivery date of the disconnect (H36555) is August 24, 2022.
   b. Anticipated delivery date of the disconnect (H365) is September 7, 2022.
   c. Anticipated delivery date of electrical switchboard is April 03, 2023.
6. Contractor may have access to site to begin construction not earlier than October 21, 2022.
7. All pipe connections to existing shall be complete by February 28, 2023.
8. All electrical shutdowns shall be complete by May 1, 2023.
9. Construction substantial completion must be prior to June 1, 2023.

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.

Work to be performed	Subcontractor Name,	City, State

Mechanical Contractor: _____

Electrical Contractor: _____

6. SUPPLIER DIVERSITY PARTICIPATION GOALS

a. The Contractor shall have as a goal, subcontracting with Minority Business Enterprise (MBE) of TEN PERCENT (10%); Women Business Enterprise (WBE), Disadvantage Business Enterprise (DBE), and/or Veteran Owned Business of TEN PERCENT (10%); and with Service Disabled Veteran Owned Business (SDVE) of three percent (3%) of awarded contract price for work to be performed.

b. Requests for waiver of this goal shall be submitted on the attached Application For Waiver form. A determination by the Director of Facilities Planning & Development, UM, that a good faith effort has not been made by Contractor to achieve above stated goal may result in rejection of bid.

c. The Undersigned proposes to perform work with following 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 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.

Authorized Signature	Date
Printed Name	Title
Company Name	
Mailing Address	
City, State, Zip	
Phone No.	Federal Employer ID No.
Fax No.	E-Mail Address
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).

Project & Address	Owner/Owner's Representative	Phone Number	Architect	Amount of your Contract	Percent Completed

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.

Project & Address	Owner/Owner's Representative	Phone Number	Architect	Amount of your Contract	Percent Completed

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_____

AFFIDAVIT

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

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

Signature _____

Name _____

Title _____

Date _____

Corporate Seal (where appropriate)

Date _____

State of _____

County of _____

On this _____ day of _____, 19_,

before me appeared (name) _____ to me personally known, who, being duly sworn, did execute the foregoing affidavit, and did state that he or she was properly authorized by (name of firm)

_____

_____to execute the affidavit and did so as his or her own free act and deed.

(Seal)

Notary Public _____

Commission expires _____

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 DIVERSITYAGENCIES

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
W: www.flystl.com/business/business-diversity-development-1/directories

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.mwdbe.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.mwdbe.com/?TN=kcmohrd

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

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

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

Minority Newspapers

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

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

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

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

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

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

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

AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION

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

1. Diverse Firm:_____

   Contact Name: _____

   Address:_____

   Phone No.:_____ E-Mail:_____

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

2. Is the proposed diverse firm certified by an approved agency [see IFB article 15]? Yes ☐ No ☐

   Agency: _____[attach copy of certification authorization from agency]

   Certification Number:_____

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

	Scope of Work	Bid/Contract Amount	Final Dollar Amount
Base Bid			
Alternate #1			
Alternate #2			
Alternate #3			
Alternate #4			
Alternate #5			
Alternate #6			

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

Page No.

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 anything 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 workdays) 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, andmanufactured in marketable quantity and quality in the Stateof 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.

A 3-point Service-Disabled Veteran Enterprises (SDVE) bonus preference shall apply to this contract. The 3 bonus points can be obtained by a certified, Missouri based SDVE performing a commercially useful function, (as defined in Article 1 of the General Conditions of the Contract for Construction) either by submitting a bid directly to the Owner, or through the utilization of certified SDVE subcontractors and/or suppliers, whose participation provides atleast 3% of the total bid amount. A firm does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of SDVE participation. In determining whether a firm is such an extra participant, the Owner will examine similar transactions, particularly those in which SDVEs do not participate. The 3-point bonus preference shall be calculated and applied by reducing the bid amount of the eligible bidder by three (3) percent of the apparent low responsive bidder's bid. Based on this calculation, if the eligible bidder's resulting total bid valuation is less than the apparent low responsive bidder's bid, the eligible bid becomes the apparent low responsive bid. This reduction is for evaluation purposes only and will have no impact on the actual amount(s) of the eligible bidder's bid or the amount(s) of any contract awarded. The submitted bid form must include a minimum of 3% SDVE participation to obtain the three (3) point bonus. For every SDVE firm utilized, a completed AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION form shall be submitted to the Owner within 24 hours of the receipt of bids. Failure to do so may be grounds for rejection of the SDVE bonus preference.

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.

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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.

15.5 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 listof certified firms may be obtained by contacting the agencies listed in the proposal form document "Supplier Diversity Certifying Agencies." Any firm listed as disadvantaged by any of the identified agencies will be classified as a diverse firm by the Owner.

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

15.6 Supplier Diversity Participation Waiver

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

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

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

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

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

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

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

University of Missouri

General Conditions

of the

Contract

for

Construction

December 2021 Edition

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TABLE OF ARTICLES

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 Owner's Authorized Agent
When the term "Owner's Authorized Agent" is used herein, it shall refer to an employee or agency acting on the behalf of the Owner's Representative to perform duties related to code inspections, testing, operational systems check, certification or accreditation inspections, or other specialized work.

1.1.6 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.

1.1.7 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.

1.1.8 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 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** "African Americans", which includes persons having origins in any of the black racial groups of Africa.
- **.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.
- **.1.3** "Native Americans", which includes persons of American Indian, Eskimo, Aleut, or Native Hawaiian origin.
- **.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.
- **.1.5** "Asian-Indian Americans", which includes persons whose origins are from India, Pakistan, or Bangladesh.

.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.

.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.

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

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

U.S. citizens that are African Americans, Hispanics, Native Americans, Asian-Pacific and Subcontinent Asian Americans, and women are presumed to be socially and economically disadvantaged. Also recognized as DBE's are Historically Black Colleges and Universities (HBCU) and small businesses located in Federal HUB Zones.
To be regarded as economically disadvantaged, an individual must have a personal net worth that does not exceed $1.32 million. To be seen as a small business, a firm must meet Small Business Administration (SBA) size criteria (500 employees or less) and have average annual gross receipts not to exceed $22.41 million. To be considered a DBE/SDB, a small business owned and controlled by socially and/or economically disadvantaged individuals must receive DBE certification from one of the recognized Missouri state agencies to be recognized in this classification.

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

1.1.10 Approved
The terms "approved", "equal to", "directed", "required", "ordered", "designated", "acceptable", "compliant", "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(s) 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.

1.1.21 Force Majeure
An event or circumstance that could not have been reasonably anticipated and is out of the control of both the Owner and the Contractor.

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

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

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

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

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

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

1.2.7 Only work included in the Contract Documents is authorized, and the Contractor shall do no work other than that described therein.

1.2.8 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become familiar with local conditions under which the Work is to be

performed and correlated personal observations with requirements of the Contract Documents. Contractor represents that it has performed its own investigation and examination of the Work site and its surroundings and satisfied itself before entering into this Contract as to:

.1 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 Owner

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

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

2.2 Owner's Right to Stop the Work

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

2.3 Owner's Right to Carry Out the Work

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

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

thereafter due Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to Owner.

2.4 Extent of Owner Rights

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

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

ARTICLE 3
CONTRACTOR

3.1 Contractor's Warranty

3.1.1 The Contractor warrants all equipment and materials furnished, and work performed, under this Contract, against defective materials and workmanship for a period of twelve months after acceptance as provided in this Contract, unless a longer period is specified, regardless of whether the same were furnished or performed by the Contractor or any Subcontractors of any tier. Upon written notice from the Owner of any breech 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 breech 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, Regulations, Permits, Codes, and Inspections

3.2.1 The Contractor shall, without additional expense to the Owner, comply with all applicable laws, ordinances, rules, permit requirements, codes, 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.

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 the 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 benchmark 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 workday 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 or inspection 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 compliant and 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 and code 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 smudges 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 damages, compensation or benefits payable by or for the Contractor or a Subcontractor of any tier under workers' or workmen's compensation acts, disability benefit acts or other employee benefit acts.

3.9.4 The obligations of the Contractor under Paragraph 3.9.1 shall not extend to the liability of the Architect, his agents or employees, arising out of the preparation and approval of maps, drawings, opinions, reports, surveys, Change Orders, designs, or Specifications.

3.10 Patents

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

3.10.2 If the Contractor uses any design, device, or material covered by letters patent or copyright, he shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device, or material. It is mutually agreed and understood, without exception, that the Contract Sum include, 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 Delegated Design

3.11.1 If the Contract Documents specify the Contractor is responsible for the design of any work as part of the project, then the Contractor shall procure all design services and certifications necessary to complete the Work as specified, from a design professional licensed in the State of Missouri. The signature and seal of that design professional shall appear on all drawings, calculations, specifications, certifications, shop drawings, and other submittals related to the Work. The design professional shall maintain insurance as required per Article 11.

3.12 Materials, Labor, and Workmanship

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

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

3.12.3 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.

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

3.12.5 Materials and workmanship shall be subject to inspection, examination, and testing 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.

3.12.6 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.

3.12.7 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.

3.12.8 Substitutions

3.12.8.1 A substitution is a Contractor proposal of an alternate product or method in lieu of what has been specified or shown in the Contract Documents, which is not an "or equal" as set forth in Section 3.12.1.

3.12.8.2 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 Document requirements and is code compliant, except as specifically disclosed and set forth in the affidavit and (b) the Contractor accepts the warranty and correction obligations in connection with the proposed substitution as if originally specified by the Architect. Proposals for substitutions shall be submitted to the Architect and Owner's Representative in sufficient time to allow the Architect and Owner's Representative no less than ten (10) working days for review. No substitution will be considered or allowed without the Contractor's submittal of complete substantiating data and information as stated herein.

3.12.8.3 Substitutions may be rejected without explanation at the 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.

3.12.8.4 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 substitution.

3.13 Approved Equal

3.13.1 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 and is code compliant.

3.13.2 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.

3.13.3 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.

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

3.14.1 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.

3.14.2 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.

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

3.14.4 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.

3.14.5 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.

3.14.6 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 provided, 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.

3.14.7 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.

3.14.8 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.

3.14.9 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.

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

3.14.11 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.

3.14.12 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.

3.14.13 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.

3.14.14 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.

3.15 Record Drawings

3.15.1 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.

3.16 Operating Instructions and Service Manuals

3.16.1 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.

3.16.2 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.

3.17 Taxes

3.17.1 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.

3.17.2 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.

3.17.3 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.

3.17.4 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.

3.17.5 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.

3.18 Contractor's Construction Schedules

3.18.1 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.

3.18.2 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.

3.18.3 As time is of the essence to this contract, the University expects that the Contractor will take all necessary steps to ensure 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 schedule 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.

3.18. 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, the Owner's Representative, and the Owner's Authorized Agent 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 recision. 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 inspections which the Contractor had the opportunity to make or should have performed in connection with the Project.

4.6 Claim for Additional Cost

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

4.7 Claims for Additional Time

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

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

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

4.7.3 A Force Majeure event or circumstance shall not be the basis of a claim by the Contractor seeking an adjustment in the Contract amount for costs or expenses of any type. With the exception of weather delays which are administered under this Article 4, and not withstanding other requirements of the Contract, all Force Majeure events resulting in a delay

to the critical path of the project shall be administered as provided in Article 8.

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, 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, non-compliant, 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.

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

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

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

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

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

.3 Equipment: Breakdown for required equipment shall itemize (at a minimum) delivery / pick-up charge, hourly

rate and hours used. Operator hours and rate shall not be included in the equipment breakdown. Contractor must use the most cost-effective equipment available in the area and should not exceed the rates listed in the Rental Rate Blue Book for Construction Equipment (Blue Book). Contractor shall submit documentation for the Blue Book to support the rate being requested.

7.2 Construction Change Directive

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

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

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

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

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

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

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

7.3 Overhead and Profit

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

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

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

15% To the Contractor or the Subcontractor of any tier for Work performed with their respective forces or materials purchased

5% To the Contractor on Work performed by other than his forces

5% To first tier Subcontractor on Work performed by his Subcontractor

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

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

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

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

Overhead and Profit

7.5% Credit to the Owner from the Contractor or Subcontractor of any tier for Work performed with their respective forces or materials purchased

2.5% Credit to the Owner from the Contractor on Work performed by other than his forces

2.5% Credit to the Owner from the first tier Subcontractor on Work performed by his Subcontractor of any tier

7.4 Extended General Conditions

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

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

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

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

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

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

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

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

7.5 Emergency Work

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

ARTICLE 8
TIME

8.1 Progress and Completion

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

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

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

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

8.2 Delay in Completion

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

8.2.2 All time limits stated in the Contract are of the essence of the Contract. However, if the Contractor is delayed at any time in the progress of the Work by any act or neglect of the Owner or by the Owner's Representative, by changes ordered in the Work, Force Majeure including but not limited to war, armed conflict, riot, civil commotion or disorder, act of terrorism or sabotage; epidemic, pandemic, outbreaks of infectious disease or any other public health crisis, including quarantine or other employee restrictions, compliance with any law or governmental order, rule, regulation or direction, curfew restriction, act of God or natural disaster such as earthquake, volcanic activity, landslide, tidal wave, tsunami, flood, damage or destruction by lightning, drought; explosion, fire, destruction of machines, equipment, prolonged break-down of transport, telecommunication or electric current; general labor disturbance such as but not limited to boycott, strike and lock-out, occupation of factories and premises, 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) justifying the delay 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 of 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. If a Force Majeure is approved by the Owner as the basis for a delay claim, an adjustment in the contract time to the extent the Force Majeure impacts the schedule is the only remedy. No increase in the contract sum for any reason shall be allowed due to a Force Majeure.

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 claims due to or caused by any events beyond the control of both the Owner and Contractor defined herein as Force Majeure. 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 provide written notice to the Owner within seven (7) calendar days of the event giving rise to such claim. 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, but in no case shall Force Majeure be the basis of an increase in the Contract sum. 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 to 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 a Bill of Sale and Bailment Agreement on forms provided by the Owner's

Representative, 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.

.11 The Contractor shall furnish and maintain insurance covering the replacement cost of the material stored offsite against all losses and shall furnish proof of coverage with the application for payment for material stored offsite.

.12 The Contractor is responsible for all costs related to storage and handling of material stored offsite unless otherwise directed by the Owner's Representative.

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

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

9.5 Approval for Payment

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

9.6 Decisions to Withhold Approval

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

.1 defective or non-compliant 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 1.1.14 as certified by the Owner.

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

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

9.10 Partial Occupancy or Use

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

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

9.11 Final Completion and Final Payment

9.11.1 Upon receipt of written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Owner's Representative and the Architect will promptly make such inspection and, when the Owner's Representative and Architect find the Work acceptable under the Contract Documents and the Contract fully performed, the Owner's Representative will promptly issue a final approval for payment; otherwise, Owner's

Representative will return Contractor's Final Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application. Submission of a Final Application for Payment shall constitute a further representation that conditions listed in Paragraph 9.11.2 as precedent to the Contractor's being entitled to final payment have been fulfilled. All warranties and guarantees required under or pursuant to the Contract Documents shall be assembled and delivered by the Contractor to the Owner's Representative as part of the final Application for Payment. The final approval for payment will not be issued by the Owner's Representative until all warranties and guarantees have been received and accepted by the Owner.

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

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

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

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

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

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

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

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

ARTICLE 10
PROTECTION OF PERSONS AND PROPERTY

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, standards, codes, 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 its employees and its 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.

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

ARTICLE 11
INSURANCE & BONDS

11.1 Insurance

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

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

11.2 Commercial General Liability

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

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

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

insurance shall cover the Contractor's indemnity obligations contained in the Contract Documents.

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

11.2.5 "The officers, employees, and agents of 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/Other Requirements

11.5.1 Any Consultant/Contractor providing professional design services as part of the contract shall be required to provide and maintain, from the date of this Contract and for a period of ten (10) years after the date of Final Completion, Professional Liability insurance to cover any claims, including but not limited to errors, omissions, and negligence, which may arise from the Design and related Services performed by the Consultant. The minimum limits for such Policy shall be $1,000,000.00 per occurrence/$1,000,000.00 aggregate. The insurance afforded by the policy shall meet the requirements of this Section 11.2 and Section 11.5 relating to CGL Policies, and without limiting the foregoing, shall be extended to cover the liability of "The officers, employees, and agents of The Curators of the University of Missouri", who shall be named as additional insureds therein, and this liability is assumed in writing by the Contractor's Consultant under the written Subcontract described herein. 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, or non-compliant 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, codes, 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, the Owner's Authorized Agent, or entity acceptable to the Owner, and the Contractor shall bear related costs of tests, inspections, and approvals as required in the Contract Documents. The Contractor shall give the Architect, Owner's Representative, and the Owner's Authorized Agent timely notice of when and where tests and inspections are to be made so the Architect, the Owner's Representative and/or the Owner's Authorized Agent may observe procedures or perform the necessary tests or inspections.

13.3.2 If the Architect, Owner's Representative, or the Owner's Authorized Agent 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, the Owner's Representative or the Owner's Authorized Agent, of when and where tests and inspections are to be made so the Architect, Owner's Representative and/or the Owner's Authorized Agent , ~~so~~ may choose that the tests or inspections can be performed or observed. 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 and Owner's Authorized Agent'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 ICC International Fire Code
.5 ICC International Fuel Gas Code
.6 NFPA 70 National Electric Code (NEC)
.7 Americans with Disabilities Act – Standards for Accessible Design.
.8 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
.9 NFPA 101 Life Safety Code (as noted above)
.10 American Concrete Institute (ACI)
.11 American National Standards Institute (ANSI)
.12 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
.13 American Refrigeration Institute (ARI)
.14 American Society for Testing and Materials (ASTM)
.15 Missouri Standard Specification for Highway Construction, Missouri State Highway Commission

.16 National Electrical Manufacturers Association (NEMA)

.17 Underwriter's Laboratories, Inc. (UL), Federal Specifications

.18 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 Certification

13.10.1 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).

13.10.2 If this contract is for $100,000 or more, and if the Contractor is a company with ten (10) or more employees, then Contractor certifies that it, and any company affiliated with it, does not boycott Israel, and will not boycott Israel during the term of this Contract. In this paragraph, the terms "company" and "boycott Israel" shall have the meanings described in Section 34.600 of the Missouri Revised Statutes.

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, codes, regulations or orders of an authority having jurisdiction;

.5 disregards the authority of the Owner's Representative, Architect, or Owner's Authorized Agent;

.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 Architects services and expenses made necessary thereby, such excess will be paid to the Contractor; but, if such expenses of Owner to finish the Work shall exceed the unpaid balance, the Contractor and its surety shall be liable for, and shall pay the difference and any damages to the Owner. The obligation of the Contractor and its surety for payment of said amounts shall survive termination of the Contract.

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

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

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

14.2 Suspension by the Owner for Convenience

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

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

.1 that performance is, was, or would have been so suspended, delayed or interrupted by another cause for which the Contractor in whole or in part is responsible, or

.2 that an equitable adjustment is made or denied under another provision of this Contract.

14.3 Owner's Termination for Convenience

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

14.3.2 Upon receipt of a notice of termination for convenience, the Contractor shall immediately, in accordance with instructions from the Owner, proceed with performance

of the following duties regardless of delay in determining or adjusting amounts due under this Paragraph:

.1 cease operation as specified in the notice;

.2 place no further orders and enter into no further subcontracts for materials, labor, services or facilities except as necessary to complete Work not terminated;

.3 terminate all subcontracts and orders to the extent they relate to the Work terminated;

.4 proceed to complete the performance of Work not terminated; and

.5 take actions that may be necessary, or that the Owner may direct, for the protection and preservation of the terminated Work.

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

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

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

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 workday) 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.

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 Engineer, dated August 25, 2022 bearing name “EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER”, project number “CP212233”.

b. Mechanical Engineer

Ross & Baruzzini, Inc.
6 South Old Orchard
St. Louis, Missouri 63119
Phone: 1 (800) 404-7677
Contact: Randy J Diemer, P.E.
Email: rdiemer@rossbar.com

c. Electrical Engineer

Ross & Baruzzini, Inc.
6 South Old Orchard
St. Louis, Missouri 63119
Phone: 1 (800) 404-7677
Contact: Jim Partsch
Email: jpartsch@rossbar.com

f. Other Definitions: See Article 1., General Conditions.

2. SPECIAL SCHEDULING REQUIREMENTS

a. Special scheduling requirements supplemental to the bid form:
   1. All shutdowns to the chilled water system must be coordinated with Owner’s Representative.
   2. All shutdowns to the electrical system must be coordinated with Owner’s Representative.
   3. All outages to existing utilities shall be scheduled with the Owner’s Representative a minimum of 72 hours in advance of the outage.
   4. Owner purchased water cooled chiller will be delivered to East Campus Chiller Plant. Contractor shall take possession of chiller and install per the Contract Documents. Anticipated delivery date of chiller is January 20, 2023.
   5. Owner purchased electrical switchboard, variable frequency drive for the

new pump and two disconnects will be delivered to East Campus Chiller Plant. Contractor shall take possession of electrical switchboard and two disconnects and install per the Contract Documents.

a. Anticipated delivery date of the disconnect (H36555) is August 24, 2022.
b. Anticipated delivery date of the disconnect (H365) is September 7, 2022.
c. Anticipated delivery date of electrical switchboard is April 03, 2023.

6. Contractor may have access to site to begin construction not earlier than October 21, 2022.
7. All pipe connections to existing shall be complete by February 28, 2023.
8. All electrical shutdowns shall be complete by May 1, 2023.
9. Construction substantial completion must be prior to June 1, 2023.

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 installation of a new chiller, pump, and electrical equipment in the East Campus Chiller Plant building.

(2) Mechanical work shall consist of following:

i. Installation of a new 1,020-ton Owner-furnished electric water-cooled centrifugal chiller.
ii. Installation of a new condenser water pump.
iii. Installation of chilled water piping, condenser water piping, and all associated piping accessories and supports.
iv. Installation of associated controls.

(3) Electrical work shall consist of following:

v. Installation of a new Owner-furnished switchboard.
vi. Installation of two new Owner-furnished disconnects.
vii. Installation of a new 480V variable frequency drive Owner-furnished for the condenser water pump.
viii. Installation of power for a new 1,020-ton Owner-furnished electric water-cooled centrifugal chiller.

4. LOCATION

Work shall be performed under this Contract on campus of the University of Missouri - Columbia, at East Campus Chiller Plant building.

5. NUMBER OF CONSTRUCTION DOCUMENTS

a. The Owner's Representative will furnish the Contractor a copy of executed Contract and one (1) complete set of Drawings and Specifications in pdf format.

b. The Owner will furnish one (1) set of explanatory and changed Drawings at no cost 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 service of their choosing.

d. The Owner will provide electronic data files to the Contractor for their convenience and use in progressing the Work and the preparation of shop drawings or other submittal requirements required for construction of the referenced project. The electronic data files shall reflect Construction Documents and Bid Addenda only. These files will be transmitted subject to the following terms and conditions:

(1) The Owner makes no representation as to the compatibility of these files with the Contractor's hardware or software.

(2) Data contained on these electronic files shall not be used by the Contractor or anyone else for any purpose other than as a convenience in progressing the Work or in the preparation of shop drawings or other required submittals for the referenced project. Any other use or reuse by the Contractor or by others will be at their own sole risk and without liability or legal exposure to Owner. The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against the Owner and its consultants, contractors, agents, employees, and representatives that may arise out of or in connection with the use of the electronic files transmitted.

(3) Furthermore, the Contractor shall, to the fullest extent permitted by law, indemnify and hold harmless the Owner and its consultants, contractors, agents, employees, and representatives, against all damages, liabilities or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

(4) These electronic files are not contract documents. Differences may exist between these electronic files and corresponding hard-copy construction documents. The Owner makes no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the signed or sealed hard-copy construction documents prepared by the Consultant and the electronic files, the signed and sealed hard-copy construction documents shall govern. The Contractor is responsible for determining if any conflict exists. By use of these electronic files, the Contractor is not relieved of their duty to fully comply with the contract documents.

(5) Because information presented on the electronic files can be modified, unintentionally or otherwise, the Owner reserves the right to remove all indications of ownership and/or involvement from each electronic display.

(6) Under no circumstances shall delivery of the electronic files be deemed a sale by the Owner and no warranties are made, either expressed or implied, of merchantability and fitness for any particular purpose. In no event shall the Owner be liable for any loss of profit, or any consequential damages as a result of use or reuse of these electronic files.

6. SUBMITTALS

a. The Contractor shall submit for approval to the Engineer, equipment lists and Shop Drawings, as expediently 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) Submittal file name, which shall be in the following format:
Bluebeam Revu 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 Engineer electronic versions 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, seventy-two (72) hours advance notice to Owner's Representative for purpose of verifying utility locations including, but not limited to, gas, telecommunications, electric, water, steam, sewer, and nitrogen. Contractor shall minimize the number of outages, minimize the length of outages and related work shall be continuous until the utility is restored.

8. USE OF PREMISES

a. Access: Access to construction site shall be as indicated on Drawings and as directed by the Owner's Representative.

(1) The contractor superintendent shall receive one (1) access card into the facility and the code to raise the gate.

b. Parking: Contractor is allowed only to park in construction area as described on sheet X1-STAGING PLAN. No parking permits will be issued. Employee parking shall be on public streets or where directed by the Owner's Representative.

(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) Sidewalk(s) and Hardscape – Parking/driving on hardscapes is strictly prohibited unless specifically directed by the Owner's Representative through the MU sidewalk permitting process. Restricted use permits will be limited to activities that are constrained by an absolute need to access from a sidewalk. Such activities shall be considered the exception and not the norm. Adequate signage, fencing and alternate routes must be provided

in the immediate and adjacent areas.

(5) 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.

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

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

(8) 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.

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: The Contractor shall provide and maintain, in a sanitary condition, chemical type portable toilet facilities at work site for use by his personnel. Toilets and toilet location shall be subject to approval by the Owner's Representative.

f. Smoking 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 smoking 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 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 ~~is~~ are prohibited from drain disposal. Any product, including contaminated water, being discarded into the storm water or sanitary sewer systems requires written approval from the Owner through a formal "Discharge to Sewer Request" form obtained at Discharge to Sewer Request Form. The contractor should submit the form to the Owner's Representative, not to the Department of Environmental Health and Safety as the form indicates.

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.

l. **"Permit Required Confined Space" Entry Communication and Coordination**
(See OSHA 1926 subpart aa – Construction Confined Space for the definition of "permit required confined spaces" - Note: OSHA does not apply to the University. However, the University will provide a list of all known "permit required confined spaces")

There are no known "permit required confined spaces" within the project limits. Each contractor shall conduct a survey to confirm whether or not any confined spaces exist within the project limits. It is incumbent upon each contractor to list all "permit required spaces".

The Contractor shall notify the Owner's Representative if 1) conditions change resulting in a non-permit required confined space being reclassified to a "permit required confined space" after evaluation of the space by a competent person; 2) a space previously thought to be non-permit required space is classified as a "permit

required confined space"; or 3) during the course of construction a "permit required confined space" is created after evaluation by a competent person.

The Contractor shall submit to the Owner's Representative a copy of the cancelled confined space entry permit and a written report summarizing the permit space program followed and all hazards confronted or created during entry operations. This information shall be submitted within one week of cancelling the permit.

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 requirements, as indicated on Drawings, shall be constructed of 9 or 11-gauge chain link not less than six (6) feet in height and not more than 2-inch mesh with posts spaced not more than ten (10) feet apart and all corner and gate posts imbedded in concrete. All other posts shall be sufficiently secured in ground to maintain proper and adequate support of fence. Fenced in area shall have at least two (2) access gates and all gates shall be lockable.

(2) Fence screening fabric shall be used on all perimeter fencing. Fabric shall be green in color, full height of the project fence, securely attached and properly maintained throughout the duration of the project.

(3) Project worksite lay down area shall be kept continuously protected with fencing.

(4) Using existing landmarks, lamp posts, trees or other Owner property for support of fencing is strictly prohibited unless a written waiver is obtained from Owner's Representative.

(5) Use of ribbon, snow fence, chicken wire, rope, and wooden barricades as fencing is prohibited.

(6) Fencing shall be maintained in an "as-installed" condition throughout the life of the project.

(7) The Contractor may use used fencing provided it is in good condition and is satisfactory to the Owner's Representative.

c. Preserving and Protecting Existing Vegetation:

(1) Protection and compensation for damages:

(a) Trees and shrubs within work area designated to remain shall be protected from damage during construction by fixed chain link fencing or armoring as indicated on Drawings or specified herein. Plant protection devices shall be installed before work has begun and shall be maintained for duration of work unless otherwise directed by Owner's Representative.

(b) In the event that damage(s) to the Owner's trees, shrubs or vegetation occurs as a result of the Contractor's unauthorized operations, the Contractor shall pay or allow to the Owner compensation for said damage(s). Compensation 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.

(2) To prevent compaction of soil over tree roots, vehicles or equipment shall not at any time park or travel over, nor shall any materials be stored within drip line of trees designated to remain.

(3) Owner's Representative will stop work immediately when proper measures are not being employed to protect trees and shrubs. Contractor will be notified to resume work after required protection measures are implemented.

(4) Pruning of limbs necessary to repair damage or provide clearance for work shall be done by the MU Landscape Services Department. Limbs shall be cut off cleanly and cut surfaces treated according to established horticultural standards.

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 submitted during the bidding period shall be received by both the Engineer 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 Engineer's decision on the approval or disapproval of a proposed substitution and/or equal shall be final.

c. No substitutions and/or equal will be allowed for the following items:

Item	Specification Section
Chilled Water Temperature Sensors and Transmitters	230900
Split Coupled Vertical In-Line Centrifugal Pump	232123
Anchor bolts shall only be stainless steel	

d. If the Engineer 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.

11. CODES AND STANDARDS

The Contractor shall comply with applicable codes and standards as listed in General Conditions. The following codes and standards shall also apply:

a. City of Columbia - Sewer Line Installation Standards - Department of Public Works

"All sanitary sewer construction shall be in accordance with the City of Columbia Specifications and Standards and in conformance with the rules and regulations of the Missouri Clean Water Commission."

12. SPECIALTIES

1) Owner purchased water cooled chiller will be delivered to East Campus Chiller Plant. Contractor shall take possession of chiller and install per the Contract Documents. Anticipated delivery date of chiller is January 20, 2023.
2) Owner purchased electrical switchboard, variable frequency drive for the new pump and two disconnects will be delivered to East Campus Chiller Plant. Contractor shall take possession of electrical switchboard and two disconnects and install per the Contract Documents.
   a) Anticipated delivery date of the disconnect (H36555) is August 24, 2022.
   b) Anticipated delivery date of the disconnect (H365) is September 7, 2022.
   c) Anticipated delivery date of electrical switchboard is April 03, 2023.

13. PRE-BID INSPECTION

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

14. MODIFICATIONS TO INFORMATION TO BIDDERS

a. Information to Bidders:

(1) Referenced Information to Bidders, Page IFB/5.
Add new Article 15.8.5 as follows:

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

15. MODIFICATIONS TO GENERAL CONDITIONS – NOT APPLICABLE

16. 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.

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

17. PROJECT COORDINATION

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

(1) Schedule construction operations in the sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

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

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

18. BUILDING SYSTEM 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, separate from the superintendent or Project Manager, to act as the contractor's commissioning coordinator. The commissioning coordinator is responsible for planning, scheduling, coordinating, conducting and verifying all commissioning activities required by the commissioning plan and ensuring all building systems are complete, operable and ready for use by the Owner. At a minimum, building ventilation systems, chilled/hot water generation systems, hydronic distribution systems, power distributions systems and fire detection and alarm systems, as applicable.

19. MECHANICAL, ELECTRICAL, PLUMBING (MEP) PRE-INSTALLATION MEETING(S)

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

20. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS

a. The Contractor shall be represented by both a competent full-time Project Manager and a full-time on site, competent Superintendent with no other assigned duties or responsibilities from the beginning of the work until its final acceptance, unless otherwise permitted by the Owner's Representative. The superintendent for the Contractor for the general building work shall exercise general supervision over all subcontractors of any tier engaged on the work with decision-making authority of the Contractor.

b. The Contractor shall use a current industry standard (Primavera, Microsoft Project,

etc.) project scheduling software which provides as a minimum: Critical paths, milestones, estimated and actual start and completion dates, scheduled vs. actual progress, and detailed task and subtask breakdown. The following schedules shall be provided as a minimum and kept current: Overall project schedule, four- (4-) week look-ahead, and two- (2-) week look-ahead.

c. The Contractor shall furnish on-site Internet access for use by his Project Manager and superintendent. . The contractor shall utilize the Owner's secure information sharing system for submittals, construction payment process, change orders, RFI's/ASI's, O&M manuals and all other project manual requirements as directed by the Owner's Representative Field staff are also required to utilize this software as directed by the Owner's Representative.

21. 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.

22. HOT WORK PERMITTING AND GENERAL REQUIREMENTS

Hot work Requirements: The contractor shall comply with the following hot work requirements and the requirements of the International Fire Code and 2014 NFPA 51B.

a. Hot work shall be defined as any work involving burning, welding, grinding, cutting, or similar operations that are capable of initiating fires or explosions.

a. The Contractor shall utilize the hot work permit decision tree and permit provided in the 2014 NFPA 51B for all Hot Work operations.

b. A hot work permit shall be used on all hot work performed outside a designated hot work area. The hot work permit shall be posted and clearly visible within proximity

of the hot work area. The hot work permit authorizing individual (PAI) shall be as designated by the Contractor.

c. Notify the Owner's Representative 24 hours prior to starting hot work in buildings with operational fire alarm or fire suppression systems. The Owner's Representative will coordinate the appropriate system outage with Campus Maintenance personnel.

d. Unless otherwise instructed by the Owner's Representative, the Contractor shall post a copy of each completed hot work permit to the Owner's project management file system the following business day.

23. GENERAL REQUIREMENTS FOR CRANE AND HOISTING OPERATIONS

All crane and hoisting operations shall be performed in compliance with OSHA 29 CFR 1926. All Operators, riggers, and signal persons must have the proper qualifications and training necessary to perform the intended hoisting activities for this project.

a. Only fully certified and evaluated Operators shall perform equipment operations. Operators in an "Operator in Training" status shall not be used.

b. Submittal requirements:

1. Submit copies of Operator certifications, licenses, and evaluations to the Owners Representative.

2. Submit Rigger and Signal Person qualifications to the Owners Representative.

3. Unless otherwise directed by the Owners Representative, submit a lift plan and conduct a lift coordination meeting for hoisting or crane operations for any lift greater than 2,000 pounds, or for any multi pick lift. Include protective measures for existing underground utilities, occupied buildings, pedestrian and vehicle pathways, adjacent buildings and overhead power lines. If the lift is to occur over an occupied building, provide a registered structural engineer's review and verification that the building can resist the impact of a dropped load for the intended lift. If evacuation of an occupied building is necessary to conduct the lift, the decision for building evacuation or scheduling the lift for off-hours will be determined by the Owner.

24. CONSTRUCTION WASTE MANAGEMENT (for projects without a Division 02 specification)

The goal of Construction Waste Management is to divert waste from the sanitary landfill. This shall be accomplished through reuse, recycling and/or salvage of non-hazardous construction and demolition debris to the greatest extent practical. Track and report all efforts related to reuse, recycling and/or salvage materials from the project (including clean fill material). Report all material types and weights, where material was diverted, type of diversion, documentation of diversion (eg: waste or recycling tickets),

and applicable dates. In order to calculate the diversion percentage, total weights of all non-hazardous landfill material must be reported. This information shall be updated monthly utilizing the Construction Waste Management Worksheet provided here: [for MU] http://www.cf.missouri.edu/cf/pdc/contractor_information. Copies of all applicable receipts, tickets and tracking logs shall be uploaded to the Owner's information sharing website or reported as required by the Construction Project Manager.

(A summary worksheet is required prior to substantial completion).

25. 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.

END OF SECTION

Contractor Schedule

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

Jan – 5 days	Feb – 5 days	Mar – 4 days	Apr – 4 days
May – 3 days	Jun – 3 days	Jul – 2 days	Aug – 2 days
Sep – 3 days	Oct – 4 days	Nov – 4 days	Dec – 5 days

2. SCHEDULING PROCESS
   a) The intent of this section is to insure that a well-conceived plan, that addresses the milestone and completion dates spelled out in these documents, is developed with input from all stakeholders in the project. Input is limited to all reasonable requests that are consistent with the requirements of the contract documents, and do not prejudice the Contractor's ability to perform its work consistent with the contract documents.
      Further, the plan must be documented in an understandable format that allows for each stakeholder in the project to understand the plan for the construction and/or renovation contained in the Project.

   b) Contractor Requirements
      (1) Schedule Development
      Contractor shall prepare the Project Schedule using Primavera P3 or Oracle P6.
      (2) Schedule Development
      Within 4 weeks of the NTP, contractor shall prepare a schedule, in CPM format, that reflects the contractor's and each subcontractors plan for performing the contract work.

      Contractor shall review each major subcontractor's schedule with the sub and obtain the subcontractor's concurrence with the schedule, prior to submitting to the University.

(3) Schedule Updates.

(a) Schedule Updates will be conducted once a month, at a minimum.
Actual Start and Finish dates should be recorded regularly during the month. Percent Complete, or Remaining Duration shall be updated as of the data date, just prior to Contractor's submittal of the update data.

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

(c) Contractor will meet with the Owner's Representative to review the draft of the updated schedule. At this meeting, Owner's Representative and Contractor will:

(i) Review out of sequence progress, making adjustments as necessary,

(ii) Add any 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 Contractors work plan shall be added to the CPM schedule, using the actual start date of the impact, along with actually required predecessors and successors.
        (2) After the addition of the impact activity(ies), the Contractor will identify subsequent activities on the critical path, with finish to start relationships that can be realistically adjusted to overlap using good, standard construction practice.
            (a) If the adjustments above result in the completion date being brought back within the contract time period, no adjustment will be made in the contract time.
            (b) If the adjustments above still result in a completion date beyond the contract completion date, the delay shall be deemed excusable and the contract completion date shall be extended by the number of days indicated by the analysis.
            (c) Contractor agrees to continue to utilize its best efforts to make up the time caused by the delays. However the Contractor is not expected to expend costs not contemplated in its contract, in making those efforts.

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

SHOP DRAWING AND SUBMITTAL LOG

Project: EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER

Project Number: CP212233

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date ret'd	Copies To Cont'r	Owner	File
230519	**Motors**										
	Shop Drawings										
230519	**Meters and Gages**										
	Shop Drawings										
230523	**Valves**										
	Shop Drawings										
230529	**Hangers and Supports**										
	Shop Drawings										
230540	**Mechanical Vibration Isolation**										
	Shop Drawings										
230700	**Mechanical Insulation**										
	Shop Drawings										
230900	**Control Systems**										
	Shop Drawings										
232113	**Hydronic Piping**										
	Shop Drawings										

SHOP DRAWING AND SUBMITTAL LOG

Project: EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER

Project Number: CP212233

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date ret'd	Copies To Cont'r	Owner	File
232123	**Hydronic Pumps**										
	Shop Drawings										
233113	**Metal Ducts**										
	Shop Drawings										
233300	**Duct Accessories**										
	Shop Drawings										
260519	**Conductors and Cables**										
	Product Data										
	Calculations										
	Test Reports										
260526	**Grounding and Bonding**										
	Product Data										
260573	**Power System Study**										
	Preliminary Report										
	Final Reports										

SHOP DRAWING AND SUBMITTAL LOG

Project: EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER

Project Number: CP212233

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date ret'd	Copies To Cont'r	Owner	File
260913	**Electrical Power Monitoring**										
	Shop Drawings										
262813	**Fuses**										
	Shop Drawings										
260536	**Cable Tray**										
	Shop Drawings										

OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Project: EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER

Project Number: CP212233

Contractor:

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	PerformanceCurves	Startup & Operating Instructions
230513	Motors	X	X	X	X	X		X
230519	Meters and Gages	X		X	X	X		
230523	Valves	X		X	X	X		X
232113	Hydronic Piping	X		X	X	X		X
232123	Hydronic Pumps	X	X	X	X	X	X	X
236416	Packaged Liquid Chillers	X	X	X	X	X	X	X
260913	Electrical Power Monitoring	X	X	X	X	X		X
230536	Cable Trays	X		X	X	X		X
262813	Fuses	X		X	X	X		X

CLOSEOUT LOG

Project: EAST CAMPUS CHILLER PLANT – INSTALL WATER COOLED CHILLER

Project Number: CP212233

Contractor:

Section	Description	Contractor/Subcontractor	Date Rec'd	# of Copies	CPM Initials	Remarks
GC /3.11	As-built drawings					
GC /13.5.6	Final Affidavit of Supplier Diversity Participation for each Diverse firm					
SC/20	Executed commissioning plan w/ required documentation					
232123	Spare Parts					
262813	Spare Parts					
260573	Arc Flash Hazard Assessment					
	Arc Flash Labels					
260526	Grounding and Bonding					
	As-Built Plans					
	Field Test Reports					
230513	Manufacturer's Special Warranty					
230900	Manufacturer's Special Warranty					
260913	Manufacturer's Special Warranty					

CP212233 E. Campus Chiller Plant Water Cooled Chiller Commissioning Check List

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
1						
Building System Commissioning						
Commissioning Agent - Conduct pre-installation meetings per specifications.					Meeting Minutes	☑
230500						
Basic Mechanical Materials and Methods						
Conduct start-up and tests per specifications					Startup Report	☑
Hold MEP pre-installation meeting(s).					Meeting Minutes	☑
Inspect preparation and all weld passes of at least first weld for each qualified welder						☑
230513						
Motors						
Check each motor for alignment, lubrication, rotation, voltage and current and Efficiency					List of motors	☑
230519						
Meters and Gages						
Provide test plugs as specified and in accordance with owners representative requirements						☑
Verify calibration, adjustment and cleanliness of specified meters and gauges						☐
230700						
Mechanical Insulation						
Verify all valves & damper controls are extended and accessible						☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Verify proper insulation used for piping and duct work						☐
230900						
Control Systems						
Check and record amp draw on supply transformers of I/O panels					Test Report	☑
Ensure shipping material has been removed from thermostats and other control devices						☐
Post laminated control diagram in mechanical room						☐
Verify all field devices provided by contractor are terminated						☐
230990						
Testing, Adjusting, and Balancing						
Coordinate and cooperate with owner's commissioning efforts						☐
Ensure pre-test requirements as specified in paragraph 1.2C have been completed						☐
Hold Pre Balancing Conference as specified					Meeting Minutes	☑
Mark equipment settings including central positions, value indicators, fan speed control levers, etc.						☐
Notify Owner's Representative 14 days prior to the scheduled date for balancing the system.					written notification	☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
232113						
Hydronic Piping						
Pressure test piping per Field Quality Control section of specifications					test report	☑
Remove and clean all strainers after flushing system						☑
232123						
Hydronic Pumps						
Comply with requirements of "Startup Service" section of specifications					Startup Report	☑
Flush systems until strainers are clean, change strainers and clean vents						☑
Perform Demonstration section of specifications					Sign In sheet	☑
Provide Extra Materials as specified					Transmittal	☑
233113						
Metal Ducts						
test for duct leakage per "Field Quality Control" section of spec. Ducts shall meet leakage requirement prior to testing and balancing					test report	☑
233300						
Duct Accessories						
Demonstrate Proper Operation of All Fire Dampers per NFPA-90A.					test report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
236416						
Packaged Liquid-Cooled Chillers						
demonstrate per specifications					Sign in Sheet	☑
Perform Chiller Testing and Startup					test reports	☑
260500						
Common Work Results for Electrical						
Perform Field Quality Control section of specifications					Test Report	☑
Perform System Commissioning section of specifications					Commissioning Report	☑
Train all End Users on the equipment they will use on a periodic basis per Demonstration section of specifications					Sign-in Sheet	☑
Verify that every penetration through fire walls (re: life safety plans) has been properly firestopped					certification	☐
Verify underground splices are performed per NEC article 110-14(b) ensuring connections and insulation are rated for underground use						☐
260519						
Conductors and Cables						
Ensure wires are color coded per specifications						☐
Perform independent tests per "Field Quality Control" section of spec, including megohm/high pot tests					test report	☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
260526						
Grounding and Bonding for Electrical Systems						
Conduct grounding tests per specifications					test reports	☐
Perform resistance test as described in "Field Quality Control" section of spec					test report	☐
260553						
Identification for Electrical Systems						
Verify all equipment, panels, conduits and conductors are correctly labeled.						☐
260573						
Power System Studies						
Factory certified technician to set electronic overcurrent devices to approved coordination study setpoints					Inspection Report	☑
Place arcflash labels on equipment as specified						☑
SKM data to be e-mailed to MU Commissioning Engineer					SKM Data	☑
Train owners representatives in setting of overcurrent devices					Sign-up Sheet	☑
260913						
Electrical Power Monitoring and Control						
Perform Field Quality Control section of specifications					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
262923						
Variable Frequency Drives						
Provide Extra Material as specified					Transmittal	☑
Start-up of VFD's shall be by factory rep. Perform all checks per manufacturer's written start-up checklist and Field Quality Control section of specs.					field report, certification	☑

Construction Management Checklist for Energizing Utilities

(Contractor to initial each item upon completion and provide completed form to the Owner's Representative prior to energizing utility) AM #1

Water – turned on to the first valve past Energy Management's last valve.

___ Review all piping and equipment being turned on for proper installation and completed testing.
___ Insulation installed (preferred but not required)
___ Meter properly installed, working, and in readable location.
___ Contractor has swabbed out with chlorine all piping from the backflow preventer to the source while installing.
___ All bacteriological tests have been completed and passed.
___ Backflow preventer installed and tested. (will need water pressure to test)
___ Pressure test completed in piping being turned on.
___ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
___ Consultant has signed off

Steam – turned on to the first valve past Energy Management's last valve.

___ Review all piping, equipment, valves, reducing stations, relief valves, etc. for proper installation and complete testing.
___ Piping protected from the weather.
___ Insulation must be installed.
___ All hangers and bolts have been installed.
___ Meter installed, working and in readable location. (Don't need metasys to turn on.)
___ All needed traps are installed and able to be tested as they are turned on.
___ Condensate system is installed and operating including the pumping system.
___ Pressure test completed in piping being turned on.
___ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
___ Consultant has signed off

Condensate – turned on to the first valve past Energy Management's last valve.

___ Review all piping and equipment being turned on for proper installation and completed testing.
___ Piping protected from the weather.
___ Insulation installed (preferred but not required)
___ Pressure test completed in piping being turned on.
___ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
___ Consultant has signed off

Electric – turned on to the first breaker past 13.8kV transformer.

___ Review all wiring and equipment being turned on for proper installation and completed testing
___ GFCI set and tested.
___ Breakers set and tested.
___ All needed permanent grounds are installed.
___ Meter installed, working and in readable location.
___ Main switchgear protected from the weather.
___ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
___ Consultant has signed off

Chilled Water – turned on to the first valve inside of building.

___ Review all piping and equipment being turned on for proper installation and completed testing.
___ Pressure test completed in piping being turned on.
___ Insulation must be installed.
___ Meter installed, working and connected to Metasys.
___ Building pump and automatic isolation/control valve must be installed and under control.
___ If chillers are installed, automatic loop pump isolation must be installed.
___ Control valves must be installed and automatically controlled on all loads.
___ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
___ Consultant has signed off

Please see following website for suggested commissioning forms:

https://operations.missouri.edu/facilities/commissioning-forms

SECTION 1.F

INDEX OF DRAWINGS

Drawings referred to in and accompanying Project Manual consist of following sheets dated August 25, 2022**.**

G000 - COVER SHEET

X1 - STAGING

M000 - SYMBOLS, ABBREVIATIONS AND GENERAL NOTES

MD101 - MECHANICAL – GROUND LEVEL – DEMOLITION PLAN – SOUTH

MD201 - MECHANICAL SECTION VIEWS – DEMOLITION PLAN

M101 - MECHANICAL – GROUND LEVEL – NEW WORK PLAN – SOUTH

M102 - MECHANICAL – GROUND LEVEL – NEW WORK PLAN – TOWER WATER SYSTEM

M103 - MECHANICAL – GROUND LEVEL – NEW WORK PLAN – CHILLED WATER SYSTEM

M201 - MECHANICAL SECTION VIEWS

M202 - MECHANICAL SECTION VIEWS

M500 – DETAILS

M501 – DETAILS

M502 - DETAILS

M600 - SCHEDULES

M700 - CONTROLS

M701 - CONTROLS

P000 – PLUMBING SYMBOLS AND ABBREVIATIONS

P101 – PLUMBING – GROUND LEVEL & UNDERFLOOR DEMOLITOION AND NEW WORK PLAN

E000 - ELECTRICAL SYMBOLS AND ABBREVIATIONS

ED100 - ELECTRICAL – FINISH FLOOR LEVEL – DEMO & NEW WORK PLAN – NORTH

ED101 -ELECTRICAL – FINISH FLOOR LEVEL – DEMOLTION PLAN – SOUTH

ED200 – ELECTRICAL – EQUIPMENT PLATFORM LEVEL – DEMOLITION PLAN - NORTH

E101 - ELECTRICAL – FINISH FLOOR LEVEL – NEW WORK PLAN – SOUTH

E102 – ELECTRICAL – FINISH FLOOR LEVEL – NEW WORK PLAN – RM 200

E200 - ELECTRICAL – EQUIPMENT PLATFORM LEVEL – NEW WORK PLAN – NORTH

E201 - ELECTRICAL – EQUIPMENT PLATFORM LEVEL – NEW WORK PLAN – SOUTH

E202 – ELECTRICAL – EQUIPMENT PLATFORM LEVEL – NEW WORK PLAN – RM 200

E400 - ELECTRICAL SWBD-6 & 7 ONE-LINE DIAGRAMS – DEMO AND NEW WORK

E401 - ELECTRICAL SWBD 2 ONE-LINE DIAGRAMS – DEMO & NEW WORK

E402 – ELECTRICAL DETAILS

END OF SECTION

SECTION 1.G

PREVAILING WAGE RATES

Missouri
Division of Labor Standards
WAGE AND HOUR SECTION

MICHAEL L. PARSON, Governor

Annual Wage Order No. 29

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
Todd Smith, Director
Division of Labor Standards

Filed With Secretary of State: **March 10, 2022**

Last Date Objections May Be Filed: **April 11, 2022**

Prepared by Missouri Department of Labor and Industrial Relations

Building Construction Rates for
BOONE County

Section 010

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	$58.66
Boilermaker	$30.87*
Bricklayer	$51.43
Carpenter	$48.35
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	$41.91
Plasterer	
Communications Technician	$55.88
Electrician (Inside Wireman)	$55.87
Electrician Outside Lineman	$75.58
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	$30.87*
Glazier	$47.32
Ironworker	$62.10
Laborer	$41.12
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	$48.56
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	$60.81
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	$37.40
Plumber	$67.36
Pipe Fitter	
Roofer	$52.11
Sheet Metal Worker	$53.28
Sprinkler Fitter	$62.30
Truck Driver	$30.87*
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.
**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in Section 290.210 RSMo.

Heavy Construction Rates for
BOONE County

Section 010

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	$51.63
Millwright	
Pile Driver	
Electrician (Outside Lineman)	$75.58
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	$46.46
General Laborer	
Skilled Laborer	
Operating Engineer	$58.48
Group I	
Group II	
Group III	
Group IV	
Truck Driver	$30.87*
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

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 fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in Section 290.210 RSMo.

OVERTIME
and
HOLIDAYS

OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, **"overtime work"** shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

HOLIDAYS

January first;
The last Monday in May;
July fourth;
The first Monday in September;
November eleventh;
The fourth Thursday in November; and
December twenty-fifth;

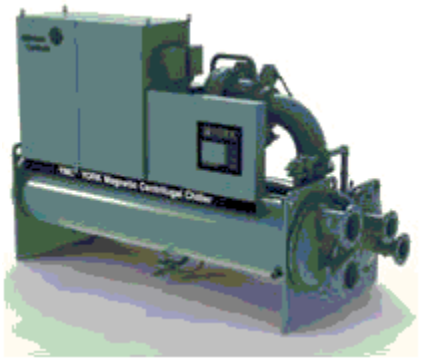
If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

END OF SECTION

EQUIPMENT SUBMITTAL FOR APPROVAL

PROJECT: UMC East CUP Rev 1-20-22

LOCATION: Columbia, MO.



YORK YMC2 MAGNETIC CENTRIFUGAL CHILLER

EQUIPMENT	YMC2 Chiller
UNIT TAGS	CH-9
QUANTITY	1

CONSULTING ENGINEER:

PREPARED BY:

DATE:
Thursday, January 20, 2022

REVISION:
1

Revision 1.0 Dated May 13, 2022
Revised to Left Hand Evaporator and Condenser Connections

TABLE OF CONTENTS

(YMC2 Chiller)

Lead Time Report Section

Product Type: YMC2 Chiller

Unit Tags: CH-9

Current lead time is 24-26 weeks

Bill Of Material (BOM) Data Section

Product Type: YMC2 Chiller

Unit Tags: CH-9

BILL OF MATERIAL DATA

EQUIPMENT	**YMC2 Chiller**
UNIT TAGS	**CH-9**
QTY	**1**

Items Included by Johnson Controls

- Motor, 460 volts, 3 phase, 60 Hz
  - Motor Enclosure: Hermetically Sealed
- Variable Speed Drive with Disconnect, factory mounted and wired.
- Microprocessor Controller with Graphics Display and BACnet Interface
- Isolation Valves
- Evaporator:
  - Marine Water Boxes, rated for 150 psig water-side pressure.
  - Flanged Connection.
  - Water Box Hinges both ends
  - Factory Thermal Insulation for Evaporator 1 1/2" inches.
  - Flow Sensors, factory mounted and wired.
  - VSD Cooling Connection
- Condenser:
  - Marine Water Boxes, rated for 150 psig water-side pressure.
  - Flanged Connection.
  - Water Box Hinges both ends
  - Flow Sensors, factory mounted and wired.
- 10 Year Parts and Labor Warranty
- 10 Year Refrigerant Warranty
- Factory performance Test. Plus 4 other points. Customer Witness to Factory Test.
- Flush Cut Tubes
- Smart Equipment Board
  - Chiller Start up (PCAT)
  - 1st Year VSD Service

Items Included but INSTALLED BY OTHERS

- 1" Thick Neoprene Pad

Items NOT Included

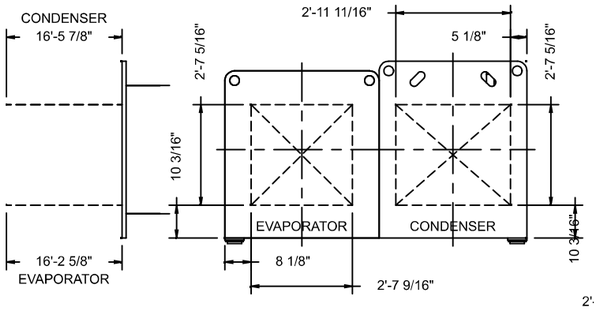
- Refrigerant monitor or SCBA
- Disassembly / Reassembly of chiller if required for installation.

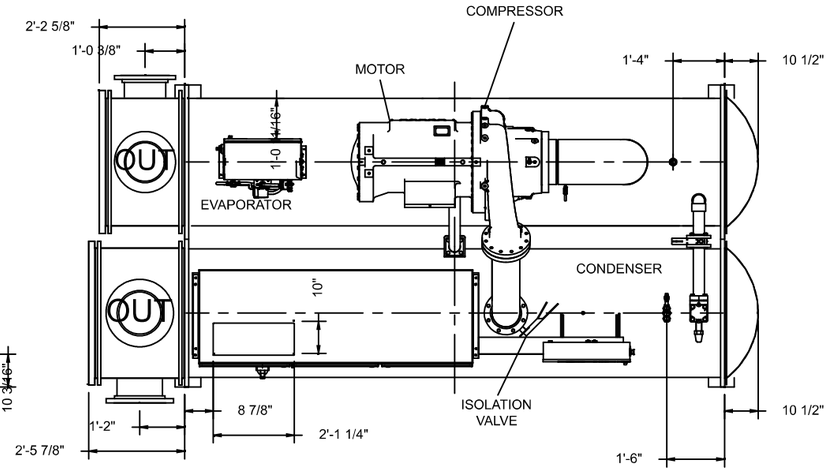
Unit and Wiring Drawings Section

Product Type: YMC2 Chiller

Unit Tags: CH-9

TUBE PULL AREA DETAIL

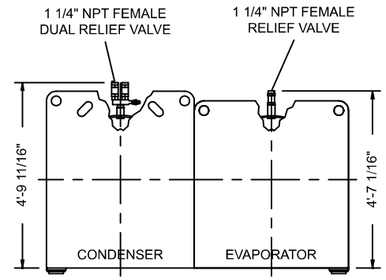


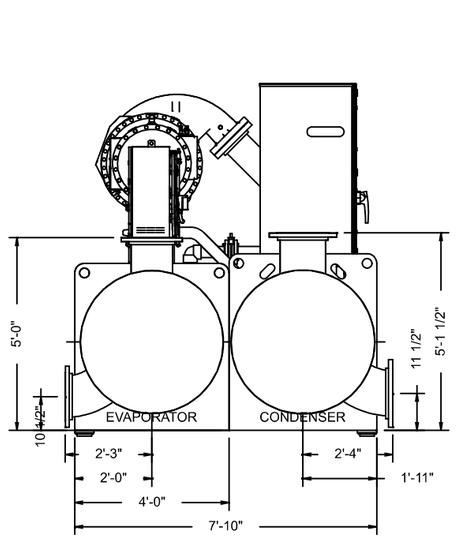


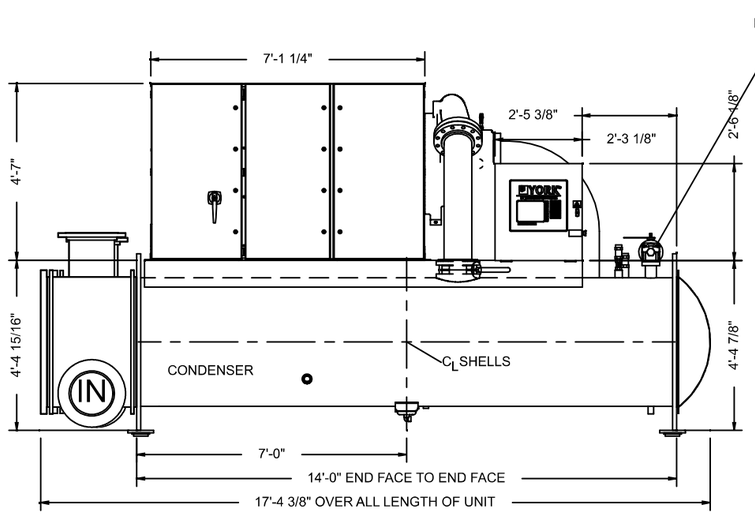
NOZZLE LEGEND

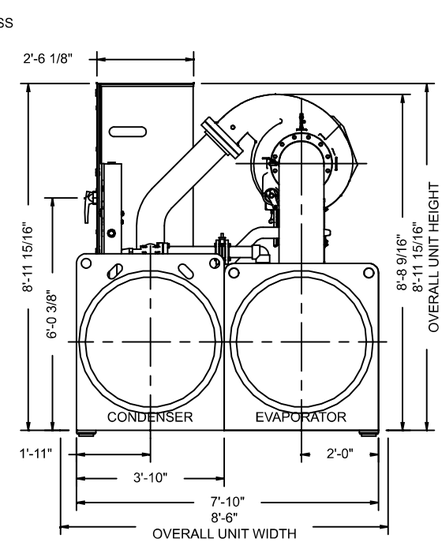
EVAPORATOR INLET	LEFT SIDE	2 PASSES	12 DIA.	(150 Psig DWP)
EVAPORATOR OUTLET	LEFT SIDE	2 PASSES	12 DIA.	(150 Psig DWP)
CONDENSER INLET	LEFT SIDE	2 PASSES	14 DIA.	(150 Psig DWP)
CONDENSER OUTLET	LEFT SIDE	2 PASSES	14 DIA.	(150 Psig DWP)

Optional water box hinges not shown.
Overall unit width and inlet nozzle length may increase up to 8".









SHIPPING WT.SHIPPING WT. OF HEAVIEST COMPONENT: 33,729 LBS, OPERATING WT. 40,161 LBS, LOAD PER ISOLATOR 10,040 LBS
(SEE PERFORMANCE PAGE FOR ADDITIONAL SHIPPING WEIGHTS)

PRODUCT DRAWING

YORK Magnetic Centrifugal Chiller
MODEL: YMC2
NOT FOR CONSTRUCTION

COMPRESSOR:	M6M6C_331FAC
EVAPORATOR:	EC3914-481-ES1-2FTL
CONDENSER:	CB3914-471-DS1-2FTL
VSD:	HYP1278XHC30B-46B
SALES MODEL:	

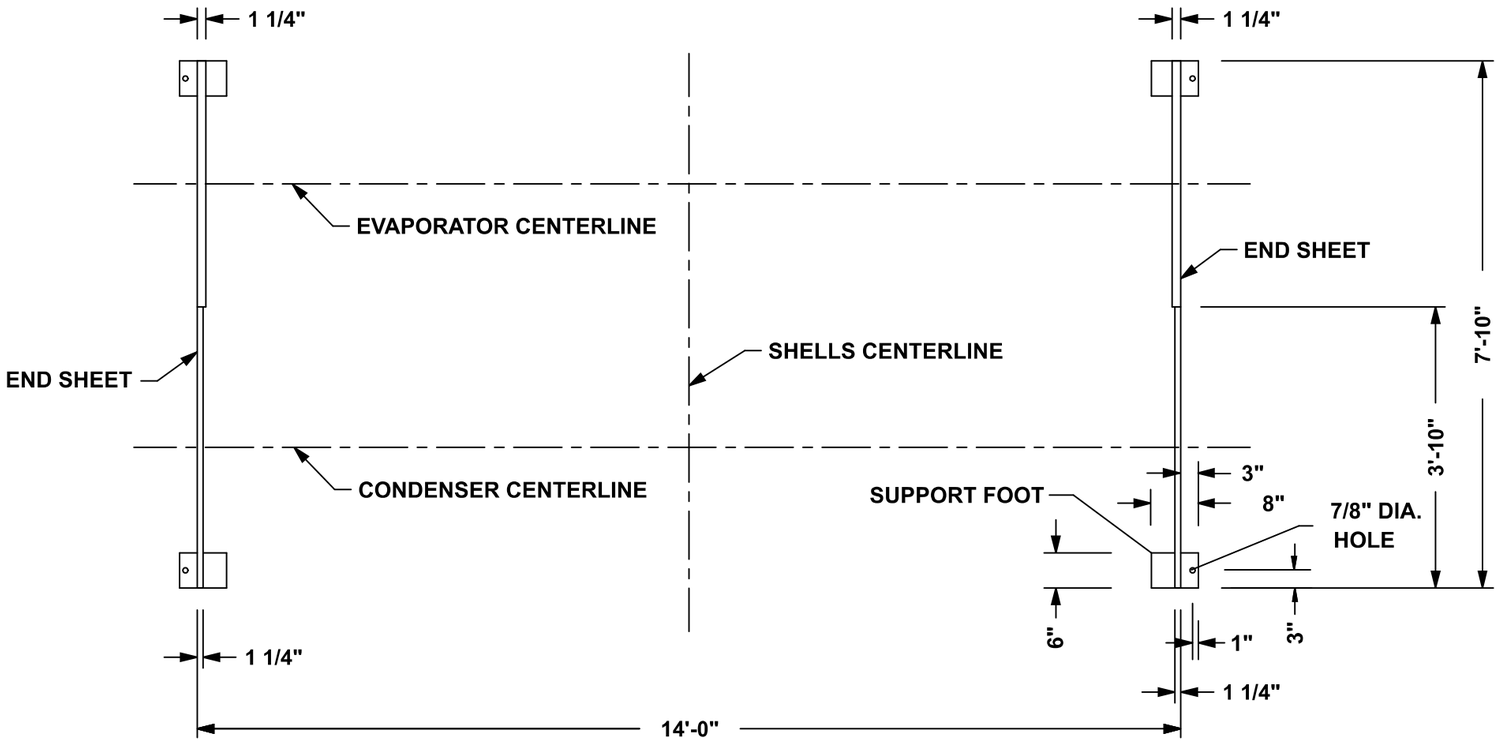
R&B - UMC - East CUP

UNIT TAG: CH-9

Date: May 13, 2022
Rev. Date: May 13, 2022
Form No.: 160.78-EG1
Dwg. Lev.: 0410
Dwg. Scale: NTS

Johnson Controls

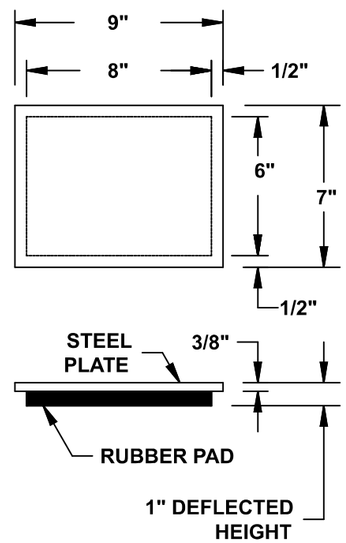
YORKworks Version:



DIMENSIONS ARE TYPICAL ALL FOUR CORNERS

FLOOR LAYOUT (NOT TO SCALE)

ISOLATOR DETAIL (N.T.S.)



ISOLATOR TO BE CENTERED
UNDER SUPPORT FOOT

PRODUCT DRAWING FLOOR LAYOUT W/NEOPRENE ISOLATORS MODEL: YMC2 **NOT FOR CONSTRUCTION**	COMPRESSOR: M6M6C_331FAC EVAPORATOR: EC3914-481-ES1-2FTL CONDENSER: CB3914-471-DS1-2FTL VSD: HYP1278XHC30B-46B SALES MODEL:	R&B - UMC - East CUP UNIT TAG: CH-9	Date: May 13, 2022 Rev. Date: May 13, 2022 Form No.: Dwg. Lev.: Dwg. Scale: NTS	Johnson Controls

YORKworks Version:

YORK®	Supersedes: 160.84-PW3 (1117) Form: 160.84-PW3 (718)
WIRING DIAGRAMS	**FIELD CONNECTIONS DIAGRAM FOR MODEL YMC² CHILLER WITH M6 COMPRESSOR**

CONTRACTOR _____	PURCHASER _____
ORDER NO. _____	JOB NAME _____
JCI CONTRACT NO. _____	LOCATION _____
JCI ORDER NO. _____	ENGINEER _____

☐ REFERENCE DATE _____	☐ APPROVAL DATE _____	☐ CONSTRUCTION DATE _____

JOB DATA:

CHILLER MODEL NO. YMC² _____ NO. OF UNITS _____

COMPRESSOR: _____ M6

MOTOR/VARIABLE SPEED DRIVE POWER: 440/460V, 60Hz; 380V, 60Hz; 415V, 50Hz or 380/400V, 50Hz

Issue Date:
July 31, 2018

IMPORTANT!

READ BEFORE PROCEEDING!

GENERAL SAFETY GUIDELINES

This equipment is a relatively complicated apparatus. During rigging, installation, operation, maintenance, or service, individuals may be exposed to certain components or conditions including, but not limited to: heavy objects, refrigerants, materials under pressure, rotating components, and both high and low voltage. Each of these items has the potential, if misused or handled improperly, to cause bodily injury or death. It is the obligation and responsibility of rigging, installation, and operating/service personnel to identify and recognize these inherent hazards, protect themselves, and proceed safely in completing their tasks. Failure to comply with any of these requirements could result in serious damage to the equipment and the property in which it is situated, as well as severe personal injury or death to themselves and people at the site.

This document is intended for use by owner-authorized rigging, installation, and operating/service personnel. It is expected that these individuals possess independent training that will enable them to perform their assigned tasks properly and safely. It is essential that, prior to performing any task on this equipment, this individual shall have read and understood the on-product labels, this document and any referenced materials. This individual shall also be familiar with and comply with all applicable industry and governmental standards and regulations pertaining to the task in question.

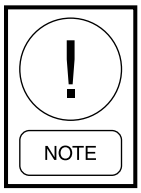
SAFETY SYMBOLS

The following symbols are used in this document to alert the reader to specific situations:

Indicates a possible hazardous situation which will result in death or serious injury if proper care is not taken.

Identifies a hazard which could lead to damage to the machine, damage to other equipment and/or environmental pollution if proper care is not taken or instructions and are not followed.

Indicates a potentially hazardous situation which will result in possible injuries or damage to equipment if proper care is not taken.



Highlights additional information useful to the technician in completing the work being performed properly.

External wiring, unless specified as an optional connection in the manufacturer's product line, is not to be connected inside the control cabinet. Devices such as relays, switches, transducers and controls and any external wiring must not be installed inside the micro panel. All wiring must be in accordance with Johnson Controls' published specifications and must be performed only by a qualified electrician. Johnson Controls will NOT be responsible for damage/problems resulting from improper connections to the controls or application of improper control signals. Failure to follow this warning will void the manufacturer's warranty and cause serious damage to property or personal injury.

CHANGEABILITY OF THIS DOCUMENT

In complying with Johnson Controls' policy for continuous product improvement, the information contained in this document is subject to change without notice. Johnson Controls makes no commitment to update or provide current information automatically to the manual or product owner. Updated manuals, if applicable, can be obtained by contacting the nearest Johnson Controls Service office or accessing the Johnson Controls QuickLIT website at http://cgproducts.johnsoncontrols.com.

It is the responsibility of rigging, lifting, and operating/service personnel to verify the applicability of these documents to the equipment. If there is any question regarding the applicability of these documents, rigging, lifting, and operating/service personnel should verify whether the equipment has been modified and if current literature is available from the owner of the equipment prior to performing any work on the chiller.

CHANGE BARS

Revisions made to this document are indicated with a line along the left or right hand column in the area the revision was made. These revisions are to technical information and any other changes in spelling, grammar or formatting are not included.

LIST OF FIGURES

VARIABLE SPEED DRIVE (MODEL 1278A)

NOTES:

1. All field wiring shall be done in accordance with the NEC codes listed within this manual. NEC articles and paragraphs cited are for reference only and may not be current NEC code.
2. ***PROPER GROUNDING IS REQUIRED:***
   - Variable Speed Drive (VSD) shall be grounded in accordance with the 2017 NEC (Paragraph 250.118).
   - Ground wires must be copper only and sized per the NEC See Table 250.122.
   - A separate grounding conductor shall be run in each conduit or for each 3 phase bundle within a cable tray. See *Figure 3 on page 11*.
   - Each ground wire shall be connected directly between the supply transformer's secondary ground and the VSD ground lug.
   - Flexible conduit is required for final connection to the VSD for vibration isolation.
   - Conduit is not an acceptable grounding means.
   - See *Table 7 on page 11* for VSD ground lug sizing.
3. Wiring, electrical conduit, junction boxes, fused disconnect switches (FDS), or circuit breakers, starters (M), pushbutton stations (PB), manual-off-automatic switch (S), flow switch (FLS), and control relays furnished by others unless otherwise specified.
4. Items marked * furnished by Johnson Controls.
5. Items marked ** available from Johnson Controls at additional cost.
6. Control power supply 115V - 50/60 Hz, 7.0 KVA capacity for control center only, is supplied by (2)-2.0 KVA and (1)-3.0 KVA control power transformers (1T)/(2T)/(6T) mounted inside the VSD, they are factory wired.
7. A removable cover plate with pilot knockouts is supplied for connection of power supply conduits. VSD power conduit connection removable cover plate (cut holes to suit) locations per *Figure 6 on page 16*. Flexible conduit must be used for final connections to VSD. **Multiple conduits shall contain an equal number of wires from each phase in each conduit to prevent overheating per the 2017 NEC (Paragraph 300-20(a)). Use copper conductors only; DO NOT USE aluminum conductors.** *See Table 7 on page 11* for factory furnished VSD terminal lug wire ranges and conduit connection provisions.

TABLE 7 - LUG DETAILS

Option	Input Voltage/ Frequency	Line Side Lugs BBL Per Terminal	Wire Range	Grounding Lug Wire Range, Qty.
Circuit Breaker	380/400/440/460 60 Hz 380/400/415 50 Hz	4	500 - 1000 mcm	#4-500 mcm, 6 bbl

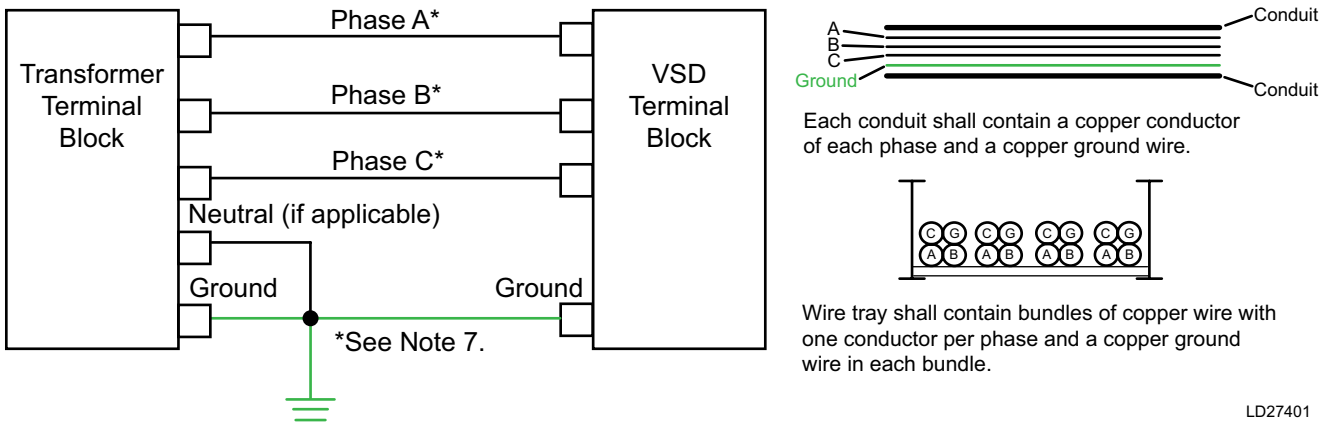


FIGURE 3 - GROUNDING VSD (1278A)

VARIABLE SPEED DRIVE (MODEL 1278A)

8. The following terminal lugs are factory furnished for field wiring supply connections. All lugs are rated AL9CU.

9. Condenser water pump motor starter (3M) holding coil to be furnished for 115V - 50/60 Hz. The power requirements for the water pump starter (3M) must be a max. of 1 Amp holding and 10 Amps inrush. If power requirements exceed this value, furnish coil for line voltage, and control relay with 115V coil (*see Note 20*).

10. Automatic control of the chilled water pump by the control center is shown. Chilled water pump motor starter (5M) holding coil to be furnished for 115V – 50/60 Hz. The power requirements for the water pump starter (5M) must be a maximum of 1 Amp holding and 8 Amps inrush. If power requirements exceed this value, furnish coil for line voltage, and control relay with 115V coil (*see Note 20*).

    - The pumps operate during compressor operation & during cycling shutdown.
    - For manual chilled water pump control, connect a manual start/stop switch as shown in the Field Connections diagram for 115VAC coils only.

TABLE 8 - CONDUIT DETAILS

Input Voltage/ Frequency	Chiller Motor Code	Max. No. of Conduits
380/400/440/460 60 Hz 380/400/415 50 Hz	M6	(4) 4 in.

11. Units shipped knocked down require field connection of harnesses to control center, power wiring between compressor motor and VSD. These harnesses and power wiring are furnished by Johnson Controls for field assembly and consist of proper lengths of flexible conduit with necessary connectors, and contain the wires (shown in *Note 12*) properly terminated and marked.

12. Wire #14 AWG copper for one way distance of less than 175 feet. Wire #12 AWG copper for one way distance of more than 175 feet, but less than 300 feet.

13. Wiring diagram for YORK control center and Field Control Modifications Form 160.84-PW4.

15. The branch circuit overcurrent protection device for the YORK VSD must be a time delay type with a rating which is the standard fuse/circuit breaker size required to protect the field supply wiring conductors per the NEC.

16. The YORK Variable Speed Drive power supply wiring ampacity shall be calculated as follows.

    Model YMC^2 minimum circuit ampacity:

    Ampacity = 1.25 (Job FLA)

    Where 125% factor per 2017 NEC (Para. 440-33).

17. The VSD is equipped with optional circuit breaker. In both cases, fast acting semiconductor fuses, downstream of the disconnecting device, to provide additional protection to the VSD. Ground fault is employed on circuit breaker model via the VSD logic control board using a hall effect current sensor one per phase. Ground fault protection is also as part of the circuit breaker protection.

18. The minimum value of line impedance shall be determined by the case in which the VSD is fed from a transformer whose kVA rating is equal to 5 times rated power of the VSD. The transformer shall be specified to have 3% impedance. The supply voltage, at VSD input terminals, during start-up must be maintained above 391 volts for 440V/460V/480V 60 Hz units, above 323 volts for 380V/400V 50/60 Hz units, above 353 volts for 415V 50 Hz units. The following Table provides allowable supply voltage range during normal operation.

TABLE 9 - VOLTAGE RANGES

Input Voltage	Voltage Range
380/400V 50/60 Hz	342-423
415V 50 Hz	374-456
440/460V 60 Hz	414-508

VARIABLE SPEED DRIVE (MODEL 1278A)

19. Maximum line voltage imbalance (calculated as the difference between any of the three line voltages and the average of the three line voltages, and multiplied by 100%) will be 5%. Maximum line voltage total harmonic distortion (THD) will be 5% per phase (from n=2nd to n=50th harmonic) when line impedance is specified as follows:

    - Minimum value of line impedance will be determined by the case in which the VSD is fed from a transformer whose kVA rating is equal to 5 times the rated power of the VSD. The transformer will be specified to have 3% impedance.
    - Maximum value of line impedance will be determined by the case in which the VSD is fed from a transformer whose kVA rating is equal to the rated power of the VSD. The transformer will be specified to have 7% impedance.

    The VSD will comply with IEEE Std. 519-1992 section 10.3.

20. Each 115VAC field-connected inductive load, i.e. relay coil, motor starter coil, etc. will have a transient suppressor wired (by others) in parallel with its coil, physically located at the coil. Spare transient suppressors are factory supplied in a bag attached to the keypad cable clamp in the OptiView Control Center.

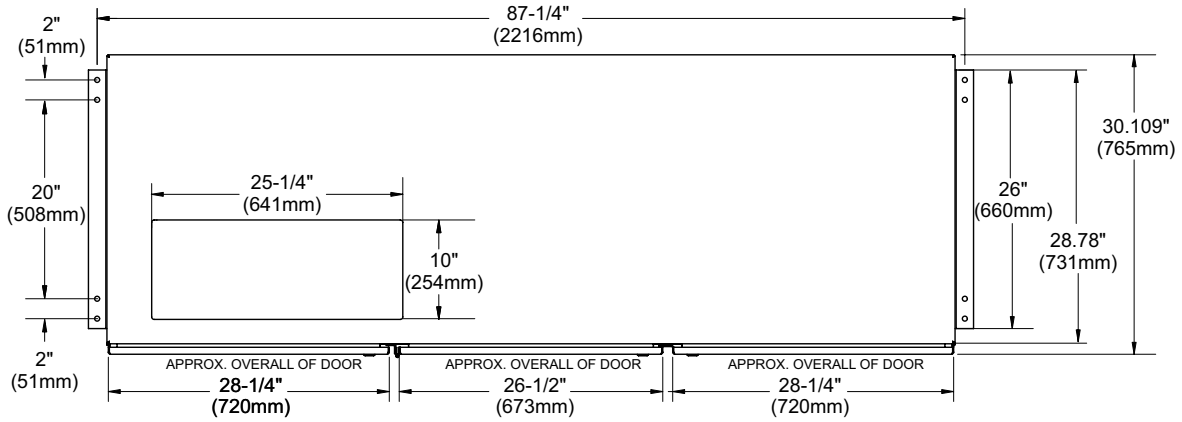
21. All switches and circuit breakers used as switches will be located so they may be operated from a readily accessible place. They will be installed per 2017 NEC (Para. 404.8).Switches and circuit breakers installed adjacent (close-coupled) to motors, appliances, or other equipment that they supply shall be permitted to be located higher than 6'-7" (2m) and to be accessible by portable means per 2017 NEC (Para. 404.8 Exception No. 2).

VARIABLE SPEED DRIVE (MODEL 1278A)

INPUT VOLTAGE/ FREQUENCY	CHILLER MOTOR CODE	VSD CIRCUIT BREAKER RATING		SEMICONDUCTOR FUSE RATING (AMPS) VAC	GROUND FAULT TRIP
		TRIP	WITHSTAND		
380/400/440/460 60 Hz 380/400/415 50 Hz	M6	1600	100,000*†	1800 @ 650VAC	360

* Per U.L. Listing of VSD
† RMS Symmetrical Amperes

TOP VIEW



FRONT VIEW

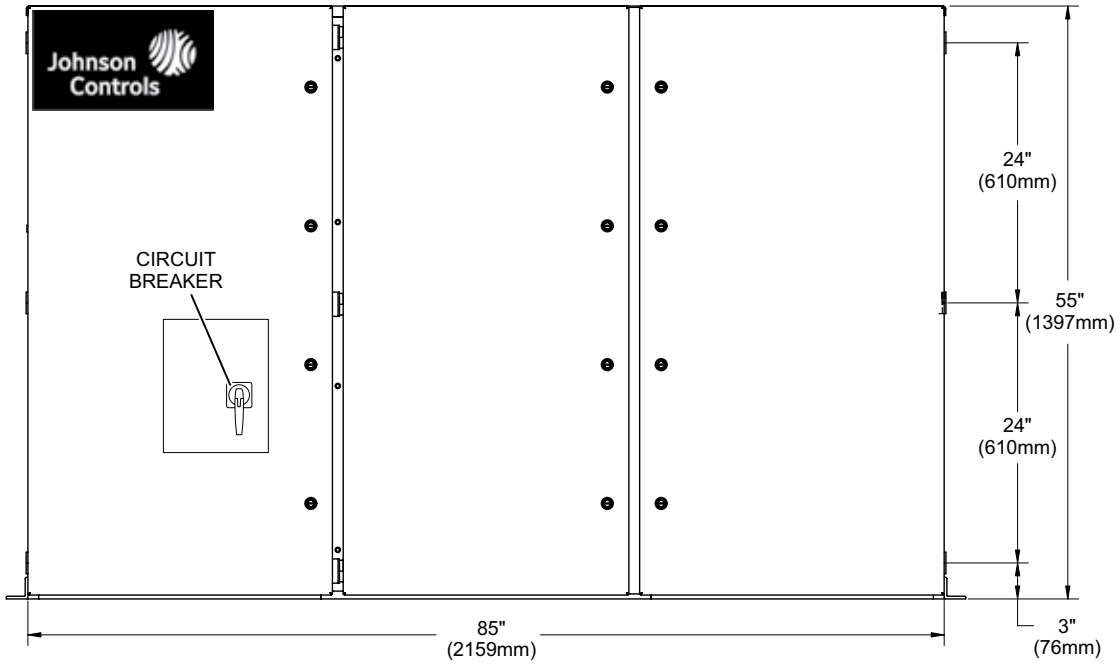


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FIGURE 6 - VARIABLE SPEED DRIVE (1278A)

FIELD CONNECTIONS

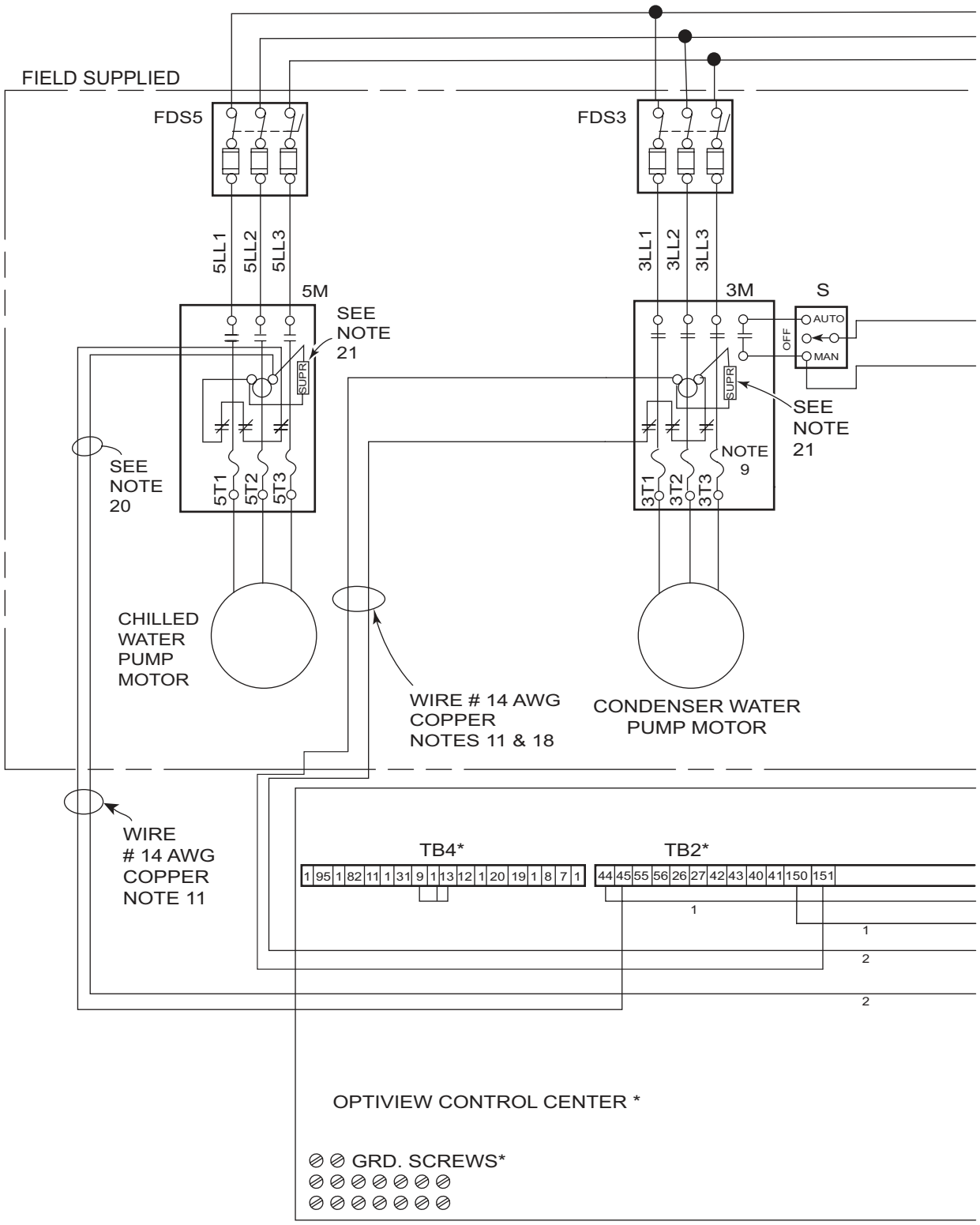

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FIGURE 7 - FIELD CONNECTIONS

FIELD CONNECTIONS (CONT'D)

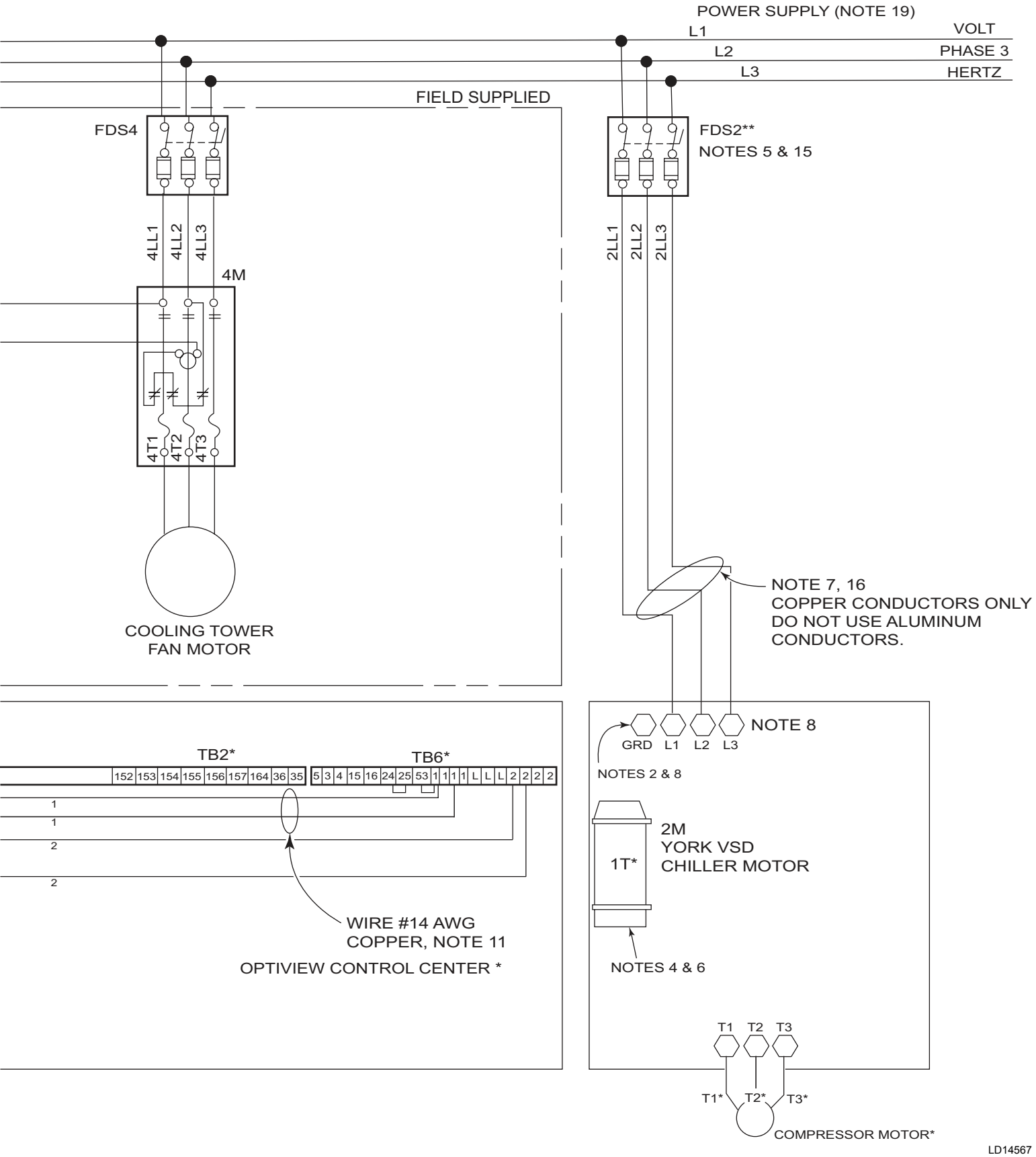

FIGURE 7 – FIELD CONNECTIONS (CONT'D)

Unit Specification Text Section

Product Type: YMC2 Chiller

Unit Tags: CH-9

YMC² CHILLER
R & B East CUP Rev 1-20-22

GENERAL
Furnish YORK YMC² Centrifugal Liquid Chilling-Unit(s) as indicated on the drawings.

Each unit shall produce a capacity of 1020 tons, cooling 2033 gpm of WATER from 55.00 to 43.00 °F when supplied with 3060 gpm of condenser water at 85.00°F. Power input shall not exceed 586.0 KW with an NPLV of 0.3179. The cooler shall be selected for 0.000100 fouling factor and a maximum liquid pressure drop of 12.0 ft H2O. Water side shall be designed for 150 psig working pressure. The condenser shall be selected for 0.000250 fouling factor and maximum liquid pressure drop of 18.6 ft H2O. Water side shall be designed for 150 psig working pressure. Power shall be supplied to the unit at 460 volts - 3 phase - 60 Hertz. The chiller shall use HFC R-134a.

Each unit shall be completely factory-packaged including evaporator, unit mounted Optispeed variable speed drive, condenser, sub-cooler, compressor, hermetic motor, Optiview control center. and all interconnecting unit piping and wiring. The chiller shall be painted prior to shipment.

Performance shall be certified in accordance with ARI Standard 550/590. Only chillers that are listed in the ARI Certification Program for Centrifugal and Rotary Screw Water Chillers are acceptable.

The initial charge of refrigerant shall be supplied, shipped in containers and cylinders for field installation or factory charged in the chiller.

COMPRESSOR
The compressor shall be a single-stage centrifugal type powered by a high speed electric motor. A cast aluminum, fully shrouded impeller shall be mounted directly to the motor shaft. The impeller shall be designed for balanced thrust, dynamically balanced and overspeed tested for smooth, vibration-free operation. Compressor castings shall be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig for HFC R-134a units.

Capacity control shall be achieved by the combined use of variable speed and variable diffuser geometry to provide fully modulating control from maximum to minimum load while maintaining constant chiller leaving water temperature.

MOTOR
The compressor motor shall be a hermetic, oil free, permanent magnet type directly coupled to the compressor. The motor will be bolted to a cast iron adapter plate mounted on the compressor to provide factory alignment of the shaft. The motor shaft shall be supported on active magnetic radial and thrust bearings. Magnetic bearing control shall be equipped with auto vibration reduction and balancing systems. During a power failure event, the magnetic bearings shall remain active throughout the compressor coast down. Rolling element bearings shall be provided as a backup to the magnetic bearings designed for emergency touch down situations. Motor stator and rotor shall be equipped with a pressure driven refrigerant cooling loop to maintain acceptable operating temperatures.

VARIABLE SPEED DRIVE
A variable speed drive shall be factory installed on the chiller. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The capacity control logic shall automatically adjust motor speed and compressor diffuser geometry for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

Drive shall be PWM type utilizing IGBT's with a power factor of 0.97 or better at all loads and speeds.

The variable speed drive shall be unit mounted in a NEMA 1 enclosure with all power and control wiring between the drive and chiller factory installed. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided. The entire chiller package shall be UL listed.

The following features will be provided:

a. Door interlocked circuit breaker capable of being padlocked.
b. Ground fault protection.

c. Over voltage and under voltage protection.
d. 3-phase sensing motor over current protection.
e. 3-phase sensing input over current protection.
f. Single phase protection.
g. Insensitive to phase rotation.
h. Over temperature protection.
i. IEEE Std. 519-1992 compliance
j. Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, self-diagnostic service parameters. Separate meters for this information will not be acceptable.
k. KW Meter - The unit's input power consumption will be measured and displayed digitally via the unit's control panel. The KW meter accuracy is typically +/- 3% of reading. KW meter scale is 0 - 788 KW
l. KWh Meter – The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel. The KWh meter is resetable and it's accuracy is typically +/- 3% of reading. KWh meter scale is 0 – 999,999 kWh.
m. Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3% of readming. Ammeter scale is 0 - 545 A RMS .
n. Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3% of reading. Voltmeter scale is 0 – 670 VAC.
o. Elapsed Time Meter – Digital readout of the unit's elapsed running time (0 – 876,600 hours, resetable) is displayed via the unit control panel.

EVAPORATOR

Evaporator shall be a shell-and-tube, hybrid falling film type designed for 235 psig working pressure on the refrigerant side. Shell shall be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side shall be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes shall not exceed 12 fps. A liquid level sight glass will be located on the side of the shell to aid in determining proper refrigerant charge. A suction baffle eliminator will be located above the tube bundle to prevent liquid refrigerant carryover to the compressor. The evaporator shall have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration.

Water boxes shall be removable to permit tube cleaning and replacement. Stubout water connections having victaulic grooves will be provided. Waterboxes shall be designed for 150psi (10.3 bar) design working pressure and tested at 225 psig (15.5 bar). Vent and drain connections with plugs will be provided on each water box. Low flow protection shall be provided by a thermal-type flow sensor, factory mounted in the water nozzle connection and wired to the chiller control center.

CONDENSER

Condenser shall be of the shell-and-tube type, designed for 235 psig working pressure on the refrigerant side. Shell shall be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side shall be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes shall not exceed 12 fps.

Water boxes shall be removable to permit tube cleaning and replacement. Stubout water connections having ANSI/AWWA C-606 grooves will be provided. Waterboxes shall be designed for 150 psi (10.3 bar) design working pressure and tested at 225 psig (15.5 bar). Vent and drain connections with plugs will be provided on each water box.

REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator shall be controlled by a variable orifice for improving unloading capabilities. The variable orifice control shall automatically adjust to maintain proper refrigerant level in the condenser and evaporator. This shall be controlled by monitoring refrigerant liquid level in the condenser, assuring optimal subcooler performance.

GRAPHIC CONTROL CENTER

General: The chiller shall be controlled by a stand-alone microprocessor based control center. The chiller control center shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.

Control panel: The control panel shall include a 10.4 in. diagonal color liquid crystal display (LCD) surrounded by "soft" keys which are redefined based on the screen displayed at that time. This shall be mounted in the middle of a keypad interface and installed in a locked enclosure. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage shall be available in English as standard and in other languages as an option with English always available. Data shall be displayed in either English or Metric units. Smart Freeze Point Protection shall run the chiller at 36.00°F leaving chilled water temperature, and not have nuisance trips on low water temperature. The sophisticated program and sensor shall monitor the chiller water temperature to prevent freeze up. When needed Hot Gas Bypass is available as an option. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop-up screen with the allowable ranges, so that the chiller can not be programmed to operate outside of its design limits.

The chiller control panel shall also provide:

1.System operating information including:
- a. return and leaving chilled liquid temperature
- b. return and leaving condenser liquid temperature
- c. evaporator and condenser saturation temperature
- d. evaporator and condenser pressure
- e. compressor discharge temperature
- f. percent full load motor current
- g. motor frequency
- h. magnetic bearing levitation status
- i. magnetic bearing temperatures
- j. operating hours
- k. number of compressor starts

2. Digital programming of setpoints through the universal keypad including:
- a. leaving chilled liquid temperature
- b. percent current limit
- c. pull-down demand limiting
- d. six-week schedule for starting and stopping the chiller, pumps and tower
- e. remote reset temperature range

3.Status messages indicating:
- a. system ready to start
- b. system running
- c. system coastdown
- d. system safety shutdown-manual restart
- e. system cycling shutdown-auto restart
- f. MBC startup
- g. start inhibit

4.The text displayed within the system status and system details field shall be displayed as a color coded message to indicate severity: red for safety fault, orange for cycling faults, yellow for warnings, and green for normal messages.

5.Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include:

a.evaporator – low pressure
b. evaporator – transducer or leaving liquid probe
c. evaporator – transducer or temperature sensor
d. condenser – high pressure contacts open
e. condenser – high pressure
f. condenser – pressure transducer out of range
g. auxiliary safety – contacts closed
h. discharge – high temperature
i. discharge – low temperature
j. control panel – power failure
k. watchdog – software reboot
l. MBC – Internal Fault
m. MBC – High Bearing Temperature
n. MBC – Cable Fault
o. MBC – Speed Signal Fault
p. MBC – Overspeed Fault
q. MBC – Communication
r. MBC – High Bearing Current
s. MBC – Rotor Elongation
t. MBC – Oscillator Fault
u. MBC – Power Supply Fault
v. MBC – Unauthorized Rotation
w. MBC – No Rotation
x. VSD Shutdown – Requesting Fault Data
y. VSD – Stop contacts Open
z. VSD – DC Bus Preregulation Lockout
aa. VSD – Logic Board Plug
bb. VSD – Ground Fault
cc. VSD – Phase __ Input DCCT (A,B,C)
dd. VSD – Phase __ Motor DCCT (A,B,C)
ee. VSD – Input Current Overload
ff. VSD – 105% Motor Current Overload
gg. VSD – High Phase __ Input Baseplate Temperature (A,B,C)
hh. VSD – High Phase __ Motor Baseplate Temperature (A,B,C)
ii. VSD – Motor or Stator Current Imbalance
jj. VSD – Motor Current THD Fault
kk. VSD – Motor Synchronization Fault
ll. VSD – Rectifier Program Fault
mm. VSD – Inverter Program Fault

6.Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns shall include:

a. multiunit cycling – contacts open
b. system cycling - contacts open
c. control panel - power failure
d. leaving chilled liquid - low temperature
e. leaving chilled liquid - flow switch open
f. condenser – flow switch open
g. motor controller – contacts open

h. motor controller – loss of current
i. MBC – Position
j. MBC – Low Frequency Displacement
k. MBC – Vibration
l. MBC – High Amplifier Temperature
m. MBC – High DC/DC Temperature
n. MBC – No Levitation
o. MBC – Serial Communications Fault
p. Power Fault
q. Control Panel – Schedule
r. VSD Precharge – Low DC Bus Voltage
s. VSD – DC Bus Preregulation
t. VSD – Logic Board Power Supply
u. VSD – High DC Bus Voltage
v. VSD – High Phase __ Input Current (A,B,C)
w. VSD – High Phase __ Motor Current (A,B,C)
x. VSD – Phase __ Input Gate Driver (A,B,C)
y. VSD – Phase __ Motor Gate Driver (A,B,C
z. VSD – Single Phase Input Power
aa. VSD – DC Bus Under Voltage
bb. VSD – Low Phase __ Input Baseplate Temperature (A,B,C)
cc. VSD – Low Phase __ Motor Baseplate Temperature (A,B,C)
dd. VSD – High Internal Ambient Temperature
ee. VSD – Serial Communications
ff. VSD – Logic Board Processor
gg. VSD – Run Signal
hh. VSD Shutdown – Requesting Fault Data
ii. VSD – Stop Contacts Open
jj. VSD – Initialization Failed

7.Security access to prevent unauthorized change of setpoints, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes. Access shall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

8.Trending data with the ability to customize points of once every second to once every hour. The panel shall trend up to 6 different parameters from a list of over 140, without the need of an external monitoring system.

9.The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller due to AC power failure or battery discharge. Programmed setpoints shall be retained in lithium battery-backed RTC memory for a minimum of 11 years with power removed from the system.

10.A fused connection through a transformer in the compressor motor starter to provide individual over-current protected power for all controls.

11. A numbered terminal strip for all required field interlock wiring.

12.An RS-232 port to output all system operating data, shutdown / cycling message, and a record of the last 10 cycling or safety shutdowns to a field-supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print from 1minute to 1day.

13.The capability to interface with a building automation system to provide:
a. remote chiller start and stop
b. remote leaving chiller liquid temperature adjust
c. remote current limit setpoint adjust
d. remote ready to start contacts

e. safety shutdown contacts
f. cycling shutdown contacts
g. run contacts

STARTUP AND OPERATOR TRAINING
The services of a factory trained, field service representative will be provided to supervise the final leak testing, charging and the initial startup and conduct concurrent operator instruction.

FACTORY INSULATION
Factory-applied, anti-sweat insulation shall be attached to the cooler shell, flow chamber, tube sheets, suction connection, and (as necessary) to the auxiliary tubing. The insulation shall be a flexible, closed-cell plastic type, 3/4 thick, applied with vapor-proof cement.

ISOLATION MOUNTING
Included with the unit are four vibration isolation mounts, consisting of 1 inch thick neoprene isolation pads, for field mounting. The pads are to be mounted under the steel mounting pads on the tube sheets. Suitable for ground floor installation.

SHIPMENT Form 1
The chiller is shipped complete with miscellaneous loose items shipped together. Refrigerant charges are included.

The unit is completely assembled at the factory.
- The driveline (compressor/motor assembly) is mounted and all the necessary interconnecting piping is assembled.
- The complete unit is factory leak-tested, evacuated, and shipped charged with R-134a refrigerant.
- The OptiView™ Control Center is mounted on the unit.
- The Variable Speed Drive (VSD) is mounted, wired, and shipped with glycol.

The following items are shipped together:
- Four (4) neoprene vibration isolation pads.
- VSD Inhibitor
- Other shipped loose items, including piping, water temperature controls, wiring, etc.

Performance Ratings Section

Product Type: YMC2 Chiller

Unit Tags: CH-9

Includes:

Minimum condenser to 36F.

Factory performance data.

YMC² CHILLER
PERFORMANCE SPECIFICATION

Unit Tag	Qty	Model No.		Net Capacity (tons)	Power	Refrigerant
CH-9	1	YMC2-S3587ABS		1020	460/3/60.0	R-134a

Unit Data	Evaporator	Condenser
Compressor Model: M6C-331FAC	Model: EC3914-481-ES1-2FTL	Model: CB3914-471-DS1-2FTL
EWT (°F):	55.00	85.00
LWT (°F):	43.00	94.39
Flow Rate (gpm):	2033	3060
Pressure Drop (ft H2O):	12.0	18.6
Fluid Type (%):	WATER	WATER
Circuit No. of Passes:	2	2
Fouling Factor (ft² °F hr / Btu):	0.000100	0.000250
Tube No. / Description:	481 - 0.025" CSL Enhanced Copper (3/4")	471 - 0.025" Enhanced Copper (3/4")
Design Working Pressure (psig):	150	150
Entering Water Nozzle @ Location:	L	L
Leaving Water Nozzle @ Location:	L	L
Water Box Weight, ea (lb)(1):	779*	821*
Cover Plate Weight , ea (lb):	481	481
Return Head Weight (lb):	215	271
Water Weight (lb):	3253	3213
Water Volume(gal):	391	386
Min Flow Rate (gpm):	1424	1668
Max Flow Rate (gpm):	5696	6065

Performance Data		Electrical Data		Other	
Heat Rejection Capacity(mbtu/hr):	14.29	Job FLA:	769	Operating Wt. (lb):	40161
Job KW:	586.0	Min Circuit Ampacity(Amps):	962	Per Isolator (lb):	10040
KW/Ton.R:	0.5746	Max Fuse/Breaker:	1600	Refrigerant Wt. (lb):	2090
NPLV.IP(KW/Ton.R):	0.3179			Compressor Wt. (lb):	4400
				Ship Wt (lb):	33729
Isolation Valves:	YES				
		Type Starter: VSD w/ filter			
		VSD Model: HYP1278XHC30B-46B			

Notes:

(1) Not including cover plate on marine water boxes.
* with applicable water flanges

AHRI Message:
Auxiliary components included in total kW: Chiller Controls.

Certified in accordance with the AHRI Water-Cooled Water Chilling and Heat Pump Water-Heating Packages Certification Program, which is based on AHRI Standard 550/590 (I-P) and AHRI Standard 551/591 (SI). Certified units may be found in the AHRI Directory at www.ahridirectory.org.

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: XEngine 1.0.7989
Software Version: YW 21.04a
Date: 01/20/2022 13:26:50

SALES REPORT

Unit Specifications			
Model	YMC2-S3587AB	**Refrigerant**	R-134a
Specified Net Capacity (Tons)	1020	**Refrigerant Charge (lb)**	2090
Rated Net Capacity (Tons)	1020	**Variable Orifice**	V3
Heat Rejection Capacity (MBtu/h)	14.29		
Full Load (kW/Ton.R)	0.5746	**Isolation Valve**	Y
IPLV.IP (kW/Ton.R)	0.3060		
NPLV.IP (kW/Ton.R)	0.3179	**OptiSound Control**	Y
Input Power (kW)	586.0	**Voltage / Hz**	460 / 60.0
Starter Type	HYP1278XHC***-46B	**FLA (Amps)**	769
Compressor	M6C-331FAC	**A-Weighted SPL (dBA)**	84
Evaporator	EC3914-481-ES*-2***	**Min Circuit Ampacity**	962
Condenser	CB3914-471-DS*-2***	**Max Circuit Breaker Amps**	1600

	Evaporator	Condenser
Fluid	Water*	Water*
Tube MTI No.	481	471 / 471
Passes	2*	2*
Fouling Factor (hr-ft²-°F/Btu)	0.000100*	0.000250*
Entering Fluid Temp (°F)	55.00	85.00*
Leaving Fluid Temp (°F)	43.00*	94.39
Fluid Flow (gpm)	2033*	3060*
Fluid Pressure Drop (ft H2O)	12.0	18.6

(*) Designates User Specified Input

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Compliant with ASHRAE 90.1-2004.
Compliant with ASHRAE 90.1-2007.
Compliant with ASHRAE 90.1-2010.
Compliant with ASHRAE 90.1-2013.
Compliant with ASHRAE 90.1-2016.
Compliant with the requirements of the LEED Energy and Atmosphere Enhanced Refrigerant Management Credit (EAc4).
Materials and construction per mechanical specifications - Form 160.84-EG1.
Auxiliary components included in total kW - Chiller controls.
IECC 2012 and IECC 2015/2018 Compliant

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: XEngine 1.0.7989
Software Version: YW 21.04a
Date: 01/20/2022 13:26:50

Partload Data (Factory Test)								
% Load	Net Capacity (Tons)	% Power	Input Power (kW)	EEFT (°F)	ELFT (°F)	CEFT (°F)	CLFT (°F)	kW/Ton.R
100	1020	100	586.0	55.00	43.00	85.00	94.39	0.5746
75	765.0	53	308.8	52.00	43.00	75.00	81.74	0.4036
50	510.0	24	138.3	49.00	43.00	65.00	69.33	0.2711
25	255.0	12	71.47	46.00	43.00	65.00	67.18	0.2803

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Materials and construction per mechanical specifications - Form 160.84-EG1.
Auxiliary components included in total kW - Chiller controls.
IECC 2012 and IECC 2015/2018 Compliant

Project:
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Engineer:
Customer:

Rating Program: XEngine 1.0.7989
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Materials and construction per mechanical specifications - Form 160.84-EG1.
Auxiliary components included in total kW - Chiller controls.
IECC 2012 and IECC 2015/2018 Compliant

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: XEngine 1.0.7989
Software Version: YW 21.04a
Date: 01/20/2022 14:38:57

SALES REPORT

Unit Specifications			
Model	YMC2-S3587AB	**Refrigerant**	R-134a
Specified Net Capacity (Tons)	1020	**Refrigerant Charge (lb)**	2090
Rated Net Capacity (Tons)	1020	**Variable Orifice**	V3
Heat Rejection Capacity (MBtu/h)	14.29		
Full Load (kW/Ton.R)	0.5746	**Isolation Valve**	Y
IPLV.IP (kW/Ton.R)	0.3060		
NPLV.IP (kW/Ton.R)	0.3179	**OptiSound Control**	Y
Input Power (kW)	586.0	**Voltage / Hz**	460 / 60.0
Starter Type	HYP1278XHC***-46B	**FLA (Amps)**	769
Compressor	M6C-331FAC	**A-Weighted SPL (dBA)**	84
Evaporator	EC3914-481-ES*-2***	**Min Circuit Ampacity**	962
Condenser	CB3914-471-DS*-2***	**Max Circuit Breaker Amps**	1600

	Evaporator	Condenser
Fluid	Water*	Water*
Tube MTI No.	481	471 / 471
Passes	2*	2*
Fouling Factor (hr-ft²-°F/Btu)	0.000100*	0.000250*
Entering Fluid Temp (°F)	55.00	85.00*
Leaving Fluid Temp (°F)	43.00*	94.39
Fluid Flow (gpm)	2033*	3060*
Fluid Pressure Drop (ft H2O)	12.0	18.6

(*) Designates User Specified Input

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Compliant with the requirements of the LEED Energy and Atmosphere Enhanced Refrigerant Management Credit (EAc4).
Materials and construction per mechanical specifications - Form 160.84-EG1.
Auxiliary components included in total kW - Chiller controls.
IECC 2012 and IECC 2015/2018 Compliant

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: XEngine 1.0.7989
Software Version: YW 21.04a
Date: 01/20/2022 14:38:57

Partload Data (Minimum Condenser Water Temperature)										
CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5746	0.5422	0.5184	0.4999	0.4984	0.5034	0.5177	0.5512	0.6559	-
80.00°	0.5192	0.4887	0.4650	0.4460	0.4382	0.4357	0.4418	0.4666	0.5495	0.9527
75.00°	0.4723	0.4417	0.4148	0.3941	0.3818	0.3772	0.3812	0.4007	0.4580	0.7728
70.00°	0.4273	0.3956	0.3679	0.3467	0.3314	0.3218	0.3221	0.3348	0.3759	0.6156
65.00°	0.3855	0.3539	0.3255	0.3033	0.2848	0.2711	0.2676	0.2723	0.2960	0.4650
60.00°	0.3492	0.3135	0.2863	0.2620	0.2415	0.2248	0.2177	0.2192	0.2359	0.3109
55.00°	0.3161	0.2778	0.2488	0.2247	0.2002	0.1822	0.1710	0.1688	0.1777	0.2258
50.00°	0.2805	0.2469	0.2149	0.1869	0.1632	0.1431	0.1273	0.1344	0.1502	0.1771
45.00°	0.2626	0.2282	0.2004	0.1710	0.1380	0.1050	0.1105	0.1231	0.1479	0.2191
40.00°	0.2587	0.2273	0.2017	0.1734	0.1424	0.1075	0.1128	0.1238	0.1922	0.3111
39.00°	0.2551	0.2241	0.1997	0.1731	0.1425	0.1067	0.1119	0.1223	0.1898	0.3092
38.00°	0.2513	0.2221	0.1991	0.1729	0.1428	0.1060	0.1111	0.1209	0.1873	0.3072
37.00°	0.2496	0.2217	0.1986	0.1728	0.1431	0.1052	0.1110	0.1209	0.1848	0.3051
36.00°	0.2494	0.2215	0.1983	0.1728	0.1435	0.1053	0.1109	0.1209	0.1822	0.3031
*Values are in kW/Ton.R										
	Rated point is 60% or higher efficiency compared to design operation point.									
	Rated point is 70% or higher efficiency compared to design operation point.									
	Rated point is 80% or higher efficiency compared to design operation point.									

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Compliant with the requirements of the LEED Energy and Atmosphere Enhanced Refrigerant Management Credit (EAc4).
Materials and construction per mechanical specifications - Form 160.84-EG1.
Auxiliary components included in total kW - Chiller controls.
IECC 2012 and IECC 2015/2018 Compliant

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: XEngine 1.0.7989
Software Version: YW 21.04a
Date: 01/20/2022 14:38:57

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Materials and construction per mechanical specifications - Form 160.84-EG1.
Auxiliary components included in total kW - Chiller controls.
IECC 2012 and IECC 2015/2018 Compliant

Johnson Controls

Customer:	
Sales Order:	
Test Location:	San Antonio

Test Tolerance Summary

	100%					75%					50%					25%				
	Design Point	Test Target	Test Tol.	Min Tol	Max Tol	Design Point	Test Target	Test Tol.	Min Tol	Max Tol	Design Point	Test Target	Test Tol.	Min Tol	Max Tol	Design Point	Test Target	Test Tol.	Min Tol	Max Tol
Performance Details																				
Net Refrigerating Capacity (Tons)	1020	1020	Note 1	971.6	1068.5	765.0	765.0	Note 1	744.6	785.4	510.0	510.0	Note 1	489.6	530.4	255.0	255.0	Note 1	234.6	275.4
Power Input/Capacity (kW/Ton.R)	0.5746	0.5746	Note 2	------	.6019	0.4036	0.4036	Note 2	------	.4315	0.2711	0.2711	Note 2	------	.2969	0.2803	0.2803	Note 2	------	.3188
COP (W/W)	6.1208	6.1208	Note 2	5.8432	------	8.7141	8.7141	Note 2	8.1503	------	12.9731	12.9731	Note 2	11.8476	------	12.5473	12.5473	Note 2	11.0306	------
Evaporator Details																				
Water Flow Rate (gpm)	2033	2033	+/- 5%	1931.35	2134.65	2033	2033	+/- 5%	1931.35	2134.65	2033	2033	+/- 5%	1931.35	2134.65	2033	2033	+/- 5%	1931.35	2134.65
Entering Water Temp (°F)	55.00	54.831		------	------	52.00	51.863		------	------	49.00	48.893		------	------	46.00	45.939		------	------
Leaving Water Temp (°F)	43.00	42.829	+/- .5 °F	42.33	43.33	43.00	42.864	+/- .5 °F	42.36	43.36	43.00	42.897	+/- .5 °F	42.4	43.4	43.00	42.942	+/- .5 °F	42.44	43.44
Water Pressure Drop (ft H2O)	12.0	12.0	Note 3	------	14	12.0	12.0	Note 3	------	14	11.9	11.9	Note 3	------	13.9	11.8	11.8	Note 3	------	13.8
Fouling Factor (hr-ft²-°F/Btu)	0.0001	0.00		------	------	0.0001	0.00		------	------	0.0001	0.00		------	------	0.0001	0.00		------	------
Condenser Details																				
Water Flow Rate (gpm)	3060	3060	+/- 5%	2907	3213	3060	3060	+/- 5%	2907	3213	3060	3060	+/- 5%	2907	3213	3060	3060	+/- 5%	2907	3213
Entering Water Temp (°F)	85.00	85.583	+/- .5 °F	85.08	86.08	75.00	75.431	+/- .5 °F	74.93	75.93	65.00	65.284	+/- .5 °F	64.78	65.78	65.00	65.144	+/- .5 °F	64.64	65.64
Leaving Water Temp (°F)	94.39	94.972		------	------	81.74	82.169		------	------	69.33	69.616		------	------	67.18	67.321		------	------
Water Pressure Drop (ft H2O)	18.6	18.6	Note 3	------	21.4	19.2	19.2	Note 3	------	22.1	19.9	19.9	Note 3	------	22.9	20.0	20.0	Note 3	------	23
Fouling Factor (hr-ft²-°F/Btu)	0.00025	0.00		------	------	0.00025	0.00		------	------	0.00025	0.00		------	------	0.00025	0.00		------	------
Driveline Electrical Details																				
Voltage Average (Volts)	460	460		414	506	460	460		414	506	460	460		414	506	460	460		414	506
Current, All Phases (Amps)	769	769		------	------	411	411		------	------	188	188		------	------	101	101		------	------
Frequency (Hz)	60	60		59	61	60	60		59	61	60	60		59	61	60	60		59	61
Power (kW)	586.0	586.0	Note 4	------	------	308.8	308.8	Note 4	------	------	138.3	138.3	Note 4	------	------	71.47	71.47	Note 4	------	------
Unit Electrical Details																				
Aux Power (kW)	------	------		------	------	------	------		------	------	------	------		------	------	------	------		------	------
Total Power (KW)	586.0	586.0	Note 4	------	------	308.8	308.8	Note 4	------	------	138.3	138.3	Note 4	------	------	71.47	71.47	Note 4	------	------

Notes

Tolerances are calculated in accordance with AHRI 550/590-2018 Section 5.6 Tables 11,12 and 13

Note 1: Full load maximum capacity = (100% + Tol 1) x (design capacity), full load minimum capacity = (100% - Tol 1) x (design capacity)
Part load capacity tolerance are within 2% of full load design capacity
Tol 1 = .105 - (.07 x % load) + [+0.15 / (DTFL x % load)], DTFL = design chilled water temperature difference at full load conditions

Note 2: Maximum kW/Ton = (100% + Tol 1 calculated in Note 1) x (design kW/Ton)
Minimum COP = (design COP)/ (100% + Tol 1 calculated in Note 1)

Note 3: Max pressure drop 1.15 x design pressure drop and + 2 of ft H20 for lower design pressure drop

Note 4: As per AHRI 550/590, Tolerance is not applicable on Power (kW)

Warranties Section

Product Type: YMC2 Chiller

Unit Tags: CH-9

Sample for reference only. Actual project specific dates to be determined.

CERTIFICATE OF LIMITED WARRANTY
JOHNSON CONTROLS EQUIPMENT

Contract Number:
Ship Date: 07/22/2022

Model Number: YMC2-S3587ABS
Start Date: 08/05/2022

Serial Number: Sample only

POLICY STATEMENT

Johnson Controls (JCI) warrants all equipment and associated factory supplied materials or start-up services performed by Johnson Controls in connection therewith, against defects in workmanship and material. **The warranty period begins at start up, or six (6) months from the ship date, whichever occurs first.** Subject to the exclusions listed below, Johnson Controls, at its option, will repair or replace, FOB point of shipment, such products or components as it finds defective.

Except for reciprocating replacement compressors, which Johnson Controls warrants for a period of twelve (12) months from date of shipment, Johnson Controls warrants Johnson Controls reconditioned or replacement materials, or installation or start-up services performed by Johnson Controls in connection therewith, against defects in workmanship and material for a period of (90) days from date of shipment.

The above represents the minimum warranty policy Johnson Controls will extend to customers. Additional product specific coverage is provided as outlined herein or in separate related warranty policies. No warranty repairs or replacements will be made until payment for all equipment, materials, components, or services has been received by Johnson Controls.

Warranty Type	Warranty Duration	Expiration Date
Standard - Entire Unit - Parts and Labor	1 Year	08/05/2023
Extended - Entire Unit - Parts and Labor	10 Years	08/05/2032
Extended - Refrigerant	10 Years	08/05/2032

Alongside this limited warranty, for all new York™ air or water-cooled chillers and/or Metasys™ building automation systems installed in the US and Canada and sold through Seller owned and operated branches, Seller also provides a Year One Service Agreement for such equipment, the scope, limitations, terms and conditions of which are at https://www.johnsoncontrols.com/yearoneservice (collectively, "Year One Service"). Seller will not provide a credit against purchase price if offered Year One Service is declined.

EXCLUSIONS:

Unless specifically agreed to in the contract documents, or associated with additional warranty options listed above, this warranty does not include the following costs and expenses:

1. Labor to repair, remove, or reinstall any equipment, materials or components.
2. Special shipping, handling or transportation charges, including cranes, safety walks or other safety requirements specific to jobsites.
3. Cost of refrigerant.
4. Freight damage.
5. Field applied coatings added to any surface or heat exchanger.
6. Rental chillers.
7. Normal wear and tear or corrosion.

ALL WARRANTIES ARE VOID IF:

1. Equipment is used with refrigerants, oil, additives, or antifreeze agents other than those authorized by supplying factory.
2. Equipment is used with any material or any equipment such as evaporators, tubing, other low side equipment or refrigerant controls not approved by supplying factory.
3. Equipment has been damaged by freezing because it was not properly protected during cold weather or damaged by fire or any other conditions not ordinarily encountered.

4. Equipment is not applied, installed, operated, maintained and serviced in accordance with instructions issued by Johnson Controls.

5. Equipment is damaged due to dirt, air, moisture, or other foreign matter entering the refrigerant system.

6. Equipment is not properly stored, protected, or inspected by customer during the period from date of shipment to date of initial start-up.

7. Field coating of coil has occurred.

8. Equipment is damaged due to acts of God, abuse, including shipping damage, neglect, sabotage, or acts of terrorists.

9. Equipment has modifications carried out that have an effect on the original design of the product without such work being authorized by the factory. Any on site design changes or unit modification/replacement shall be authorized in advance by the factory.

10. Equipment is moved from the location where it is originally placed in service, unless performed by certified Johnson Controls employees who have followed Johnson Controls' then-current installation and operations procedures as evidenced by signed start-up documentation.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES AND LIABILITIES, EXPRESS OR IMPLIED IN LAW OR IN FACT, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE WARRANTIES CONTAINED HEREIN SET FORTH BUYER' S SOLE AND EXCLUSIVE REMEDY IN THE EVENT OF A DEFECT IN WORKMANSHIP OR MATERIALS. IN NO EVENT SHALL JOHNSON CONTROLS' LIABILITY FOR DIRECT OR COMPENSATORY DAMAGES EXCEED THE PAYMENTS RECEIVED BY JOHNSON CONTROLS FROM BUYER FOR THE MATERIAL OR EQUIPMENT INVOLVED, NOR SHALL JOHNSON CONTROLS BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES. THESE LIMITATIONS ON LIABILITY AND DAMAGES SHALL APPLY UNDER ALL THEORIES OF LIABILITY OR CAUSES OF ACTION, INCLUDING BUT NOT LIMITED TO, CONTRACT, WARRANTY, TORT, (INCLUDING NEGLIGENCE) OR STRICT LIABILITY. THE ABOVE LIMITATIONS SHALL INURE TO THE BENEFIT OF JOHNSON CONTROLS SUPPLIERS AND SUBCONTRACTORS.

Products furnished, but not manufactured, by Johnson Controls are not covered by this warranty. This Warranty does not apply to: i) any equipment, materials or products manufactured according to Buyer's specifications; (ii) consumable equipment, materials or products; (iii) equipment, materials or products purchased through other than JCI or a JCI authorized channel; and (iv) any software (such software being warranted under the applicable User Terms or, if none, the terms of the general end user license agreement found at http://www.johnsoncontrols.com/techterms). Products furnished but not manufactured by Johnson Controls may be covered by the manufacturer of such products and Buyer's sole and exclusive remedy for such products is limited to any warranty given by said manufacturer.

To qualify for warranty consideration under this Johnson Controls warranty, Buyer must immediately notify Johnson Controls at the earlier of the Buyer's discovery of the defect or the time at which the Buyer should have discovered the defect with the exercise of due diligence. Buyer must also promptly thereafter return to Johnson Controls (freight pre-paid by Buyer) all defective parts. Nothing herein is intended to provide warranty coverage to lessees or anyone other than Buyer and no third-parties are intended to be beneficiaries of this Limited Warranty.

LIMITED REFRIGERANT WARRANTY

Johnson Controls (JCI) warrants to the customer named herein, that JCI will provide the customer free of charge, with replacement refrigerant in the case of any refrigerant loss due to system leaks as a result of a manufacturing defect. Services to recycle contaminated refrigerant are also included in the event of system contamination resulting from a manufacturing defect. This warranty is offered within the extended warranty period and exclusions stated above and is only available in combination with entire unit parts and labor warranty. This Limited Refrigerant warranty is offered as an extension to the standard limited warranty and is subject to the same limitations and exclusions stated therein, which are hereby incorporated herein by reference. Remote evaporator, remote condenser, finned tube, and mobile units are excluded from this coverage.

VSD PARTS AND LABOR WARRANTY

Johnson Controls (JCI) warrants to the customer named herein, parts and labor for the VSD unit. It does not include any other components associated with the named equipment. This warranty is offered as an extension to the standard limited warranty and is subject to the same limitations and exclusions stated therein, which are hereby incorporated herein by reference.

If you are interested in adding additional coverage, contact your local JCI branch for more information about extended warranty.

Customer Signature: _____

Johnson Controls Representative: _____

Date: _____

Equipment Release Approval Form

SUBMITTAL NOTES

Product Type: YMC2 Chiller

Unit Tags: CH-9

The following table must be completed prior to releasing the equipment for fabrication. Please initial the column indicating the information contained in this submittal has been verified, or indicate to refer to a marked-up page.

SUBMITTAL VERIFICATION	
	Purchaser Initials
Electrical voltage and electrical connections are compatible with jobsite requirements.	
Piping / Ductwork connections shown in this submittal are correct .	
Unit tag designations are correct.	
Equipment dimensions (length, width, and height) and weights have been verified to comply with jobsite conditions and rigging requirements. Please indicate approval by your initials on all included drawings.	
Verify “Unit Hand” of any Air Handling Equipment per the definition provided on the **“Equipment Release / Configuration Process”** form.	

SUBMITTAL VERIFICATION	
	Purchaser Initials
Indicate equipment configuration choices on the **Equipment Release /Configuration Process** form (if included on this Submittal package), and sign the form.	

Important Notes:

1) Actual fabrication release cannot commence until this form is signed by the customer and returned to JCI along with a release notification want date and ship to address.

2) Equipment "lead-time" does not start until confirmed release documentation is received, and the order is actually released to the factory.

3) Modifications to equipment configurations after fabrication release may impact cost and lead-time

4) Attached configurations are as shown in the approved equipment submittals or as defined in superseding customer correspondence.

5) AHU "Side" / "Hand" orientation is relative to a person standing inside an AHU with air hitting the back of the head.

6) Note that once this document is confirmed, the equipment configurations defined by this document take precedence over all other documents.

7) "Want date" and/or "ship to address" changes made after this document is confirmed may impact cost and lead-time.

8) Air handler drawings also include shipping split explosions with corresponding weights and dimensions. If additional splits are required, there will be additional costs and the unit length will increase.

Please fill out the following table and refer to the receiving/rigging instructions in this submittal to help ensure a smooth delivery and installation of the equipment.

DELIVERY INFORMATION	
	Please fill out information below
Contact name for coordinating delivery of equipment with transportation company	
Contact phone number	
Advance notice required from transportation company prior to delivering equipment (typically 48 hours)	
Ship to address:	
Other special shipping instructions or requirements	

CUSTOMER APPROVAL:

Customer Name: _____

Signature (*) _____

Date: _____

SECTION 03 1000 – CONCRETE FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes formwork for cast-in-place concrete.

B. Related Work Specified Elsewhere:

1. Concrete Reinforcement: SECTION 032000.

2. Concrete: SECTION 033000.

1.2 REFERENCED STANDARDS

A. Applicable Standards:

1. American Concrete Institute (ACI):

a. 117 - Specifications for Tolerances for Concrete Construction and Materials.

b. 301 - Specifications for Structural Concrete.

c. 318 - Building Code Requirements for Reinforced Concrete.

d. 347 - Guide to Formwork for Concrete.

2. American Society for Testing and Materials (ASTM):

a. C31 - Making and Curing Concrete Test Specimens in the Field.

b. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

c. C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

PART 2 - PRODUCTS

2.1 MATERIALS FOR FACING:

A. Where concrete will be exposed to view after construction:

1. Use exterior grade plywood at least 5/8-inch thick or steel forms capable of producing a smooth, uniform appearance.

2. Do not use form-facing materials with raised grain, torn surfaces, worn edges, dents, or other defects that will impair the texture of concrete surfaces.

B. Where concrete will not be exposed to view after construction:

1. Exterior grade plywood at least 5/8-inch thick.

2. Steel.

3. Wood fiberboard.

4. Dressed lumber free of loose knots.

C. Treat forms with commercially available form releasing agents that will not bond with, stain, or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion, nor shall it impede the wetting of surfaces to be cured with water or curing compounds. Form releasing agents shall be VOC compliant with a maximum VOC content of 3.8 lbs/gal, or less where area restrictions are more stringent.

D. Clean forms of sawdust, dust, dirt, and other foreign materials.

2.2 FORM TIES:

A. Break-back, coil, or screw-type, except where otherwise specified.

B. Use water-seal coil type in walls below grade and in walls of water-bearing structures. Removable through-wall tappered ties shall not be used.

C. Coil type shall leave conical depression in concrete.

D. Space as required against pressure of fresh concrete.

E. The portion of the form tie remaining in place shall provide for a clearance of two times the minimum dimension of the tie, but not less than 3/4-inch, from the formed surface.

2.3 CHAMFER STRIPS:

A. Chamfer: 3/4-inch except where otherwise indicated.

B. Place in all forms to provide chamfer where concrete will have exposed projecting corners.

PART 3 - EXECUTION

3.1 FORM CONSTRUCTION

A. Conform to ACI 301, 318, and 347, except Shop Drawings for formwork, shoring, and reshoring shall not be submitted for approval.

B. Adequately brace, stiffen, and support forms to prevent perceptible deflection or settlement, and to hold plumb, level, and true to line.

C. Construct and maintain forms to the tolerances given in ACI 117.

D. Construct sufficiently tight to prevent mortar leakage.

E. Avoid offsets between adjacent forms and construct so that shores, braces, and stiffening members are in line with those below.

F. Space studs and stringers as required to support facing against concrete pressure, but not more than 12 inches for 5/8-inch plywood or 16 inches for 3/4-inch plywood. Maximum deflection of facing materials reflected on concrete surfaces exposed to view shall be 1/240 of the span between structural members of the formwork.

G. Use wales, strongbacks, shores, and bracing as required.

H. Form all necessary openings or chases for piping, ductwork, and similar items where indicated or as required for the Work.

I. Construct forms to be removable in sections without marring concrete surface.

J. Surface of forms shall provide a smooth, dense, plane surface to finished concrete where exposed to view.

K. Contractor shall be responsible for structural adequacy, design, engineering, and construction of the formwork.

L. Stay-in-place metal forms shall not be used.

3.2 TIME-IN-PLACE FOR FORMS:

A. It is the responsibility of Contractor to consider all applicable factors and leave the formwork in place until it is safe to remove them.

B. All removal shall be performed in a manner which will prevent damage to the concrete and ensure the complete safety of the structure.

C. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements.

D. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C31 and ASTM C39 at the expense of Contractor by an independent laboratory that complies with ASTM C107. Control cylinders shall be tested within 4 hours after removal from the Site.

E. Forms shall not be removed unless the minimum time or minimum compressive strength requirements below are met.

1. Formwork Not Supporting Weight of Concrete:

a. Formwork for walls, columns, sides of beams, gravity structures, slabs-on-ground and other vertical type formwork not supporting the weight of concrete shall remain in place 24-hours minimum after concrete placement is completed.

2. Formwork Supporting Weight of Concrete:

a. Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, no forms or shoring shall be loosened or removed until control concrete test cylinders indicate the concrete has attained the following compressive strengths for the respective structural members:

Structural Member	Percent of Design Compressive Strength
Unshored slab and beam forms or forms which can be removed without disturbing shores……..…….	70
Slab or beam shoring ……	85

END OF SECTION 03 1000

SECTION 03 1550 – VAPOR RETARDER

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes vapor retarder under concrete slabs on grade.

B. Related Work Specified Elsewhere:

1. Concrete: SECTION 033000.

1.2 REFERENCED STANDARDS

A. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. E96 - Test Methods for Water Vapor Transmission of Materials.

   b. E154 - Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

   c. E1745 - Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

1.3 SUBMITTALS

A. Submit as specified in DIVISION 1.

B. Include, but not limited to, the following:

1. Product specification and data.

2. Installation instructions.

PART 2 - PRODUCTS

2.1 VAPOR RETARDER:

A. Flexible, preformed sheet membrane material conforming to ASTM E1745, Class A or B having a minimum thickness of 10 mils.

B. Use under all interior concrete slabs.

PART 3 - EXECUTION

A. INSTALLATION

B. Remove sharp edges, projecting materials, and roughness which might penetrate vapor retarder.

C. Level and tamp or roll granular base.

D. Place vapor retarder sheeting with the longest dimension parallel with the direction of the concrete pour.

E. Lap vapor retarder over footing or seal to foundation wall, or both, and seal around penetrations such as utilities and columns in order to create a monolithic membrane between the surface of the slab and moisture sources below the slab and at the slab perimeter.

F. Lap joints 6 inches, or as instructed by the manufacturer, and seal with the manufacturer's recommended adhesive or pressure sensitive tape, or both.

G. Take precaution to protect vapor retarder from damage during installation of reinforcing steel and utilities and during placement of concrete.

H. Use only concrete brick type reinforcing bar supports, or provide 6"x6" protective pads of asphaltic hardboard or other material recommended by the vapor retarder manufacturer to protect the vapor retarder from puncture.

I. Do not drive stakes through the vapor retarder.

J. Repair vapor retarder damaged during placement of reinforcing or concrete as instructed by manufacturer.

END OF SECTION 03 1550

SECTION 03 2000 – CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes steel reinforcement bars, ties, welded wire fabric, bolsters, chair supports, and accessories.

B. Related Work Specified Elsewhere:

1. Concrete Formwork: SECTION 031000.

2. Concrete: SECTION 033000.

1.2 REFERENCED STANDARDS

A. Applicable Standards:

1. American Society for Testing and Materials (ASTM):

a. A82 - Steel Wire, Plain, for Concrete Reinforcement.

b. A185 - Steel Welded Wire Reinforcement, Plain, for Concrete.

c. A615/A615M - Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

d. A706/A706M - Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

2. American Concrete Institute (ACI):

a. 301 - Specifications for Structural Concrete.

b. SP-66 - Detailing Manual.

c. 318 - Building Code Requirements for Structural Concrete.

d. 117 - Specifications for Tolerances for Concrete Construction and Materials.

3. American Welding Society (AWS):

a. A5.5 - Low Alloy Steel Electrodes for Shielded Metal Arc Welding.

b. B2.1 - Welding Procedure and Performance Qualification.

c. D1.4 - Structural Welding Code - Reinforcing Steel.

4. Concrete Reinforcing Steel Institute (CRSI):

a. Manual of Standard Practice.

1.3 SUBMITTALS

A. Submit as specified in DIVISION 1.

B. Include, but not limited to, the following:

1. Complete bar schedule, bar details, and erection drawings to conform to ACI SP-66.

2. Drawing with each type of bent bar marked with identification mark. Straight bars shall have mark number or be identified by size and length.

3. Erection drawings shall be clear, easily legible, and to a minimum scale of:

a. 1/4 inch = 1 foot (1:50).

b. 1/8 inch = 1 foot (1:100) if bars in each face are shown in separate views.

4. Size and location of all openings.

5. Concrete protective cover.

6. Grade of steel.

7. Lap splice lengths.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Store steel reinforcement blocked-up off the ground and in orderly stacks.

B. Store only bars with the same identifying label in the same stack.

1.5 TESTING:

A. Perform at the mill for each heat.

B. Submit certified test results upon request.

PART 2 - PRODUCTS

2.1 REINFORCEMENT BARS, TIES, AND STIRRUPS:

A. Materials:

1. Conform to ASTM A615, Grade 60, except as otherwise specified.

2. Reinforcement indicated or specified to be welded shall conform to ASTM A706.

B. Fabrication of Bars:

1. Fabricate with cold bends conforming to the recommended dimensions shown in ACI 318.

2. Fabricate bars according to the tolerances given in ACI 117.

3. Field fabrication will be allowed only if Contractor has equipment to properly fabricate steel.

4. Attach metal or plastic tags with identifying mark or length corresponding to mark number or length on Drawing. Straight bars shall have mark number or size and length. Bent bars shall have mark number.

5. Contractor may, at his option, continue steel reinforcement through openings in walls and slabs, then field-cut the opening so that there will be the required concrete cover between ends of bars and edge of opening.

2.2 WELDED WIRE REINFORCEMENT:

A. Conform to ASTM A185 using bright basic wire conforming to ASTM A82.

B. Wire sizes W1.4 and smaller shall be galvanized.

C. Provide mats only. Rolled fabric is not acceptable.

2.3 BOLSTERS, CHAIRS, AND ACCESSORIES:

A. Conform to ACI SP-66 and the CRSI Manual of Standard Practice.

B. Provide all spacers, bolsters, chairs, ties, and other devices necessary to properly space, place, support, and fasten steel reinforcement in place during the concrete placement.

C. Metal accessories shall be galvanized or plastic-coated where legs will be exposed in finished concrete surfaces.

D. Do not use rocks, broken bricks, wood blocks, or concrete fragments for support of steel reinforcement.

2.4 PRECAST CONCRETE BLOCK BAR SUPPORTS:

A. May be used only for bar supports in slabs on ground.

B. Conform to ACI SP-66 and the CRSI Manual of Standard Practice.

C. Each block shall have a minimum of 9 square inches of bearing area. Space as required by the particular condition of weight, bearing surface, and rigidity of the steel reinforcement.

PART 3 - EXECUTION

3.1 PREPARATION FOR CONCRETE PLACEMENT

A. Place all steel reinforcement before concrete is cast in accordance with approved erection drawings, ACI 117, Chapters 7 and 12 of ACI 318, and the CRSI Manual of Standard Practice.

B. Remove oil, mill scale, pitting, mud, loose rust, ice, and other materials that would reduce bond from bars before placing.

C. Tie securely with 16-gage or larger annealed iron wire.

D. Place to maintain concrete cover to conform to ACI 117 and Chapter 7 of ACI 318, unless otherwise indicated.

E. Splice steel where indicated. Splices shall be in full contact and shall conform to Chapter 12 of ACI 318.

1. Unless otherwise indicated, lap splices shall be Class B as defined by ACI 318.

2. Splice steel using Cadweld Series T-splices where indicated or approved.

a. Provide a manufacturer's representative to give on-site instructions to all welders who will perform the splices in the field.

b. Contractor shall have the manufacturer's representative instruct, observe, and approve in writing those persons doing the welding.

c. Contractor shall arrange for the manufacturer's representative to return at the request of the Engineer.

3. Lenton Mechanical Splices:

a. Lenton mechanical splices shall be used where indicated.

b. The Lenton mechanical splices shall develop in tension and compression at least 125% of the yield strength (Fy) of the bar spliced.

c. Lenton mechanical splices shall be positive locking, taper threaded type coupler.

4. Splices in members indicated as "tension tie members" shall be made with Cadweld Series T-splices or Lenton mechanical splices in accordance with ACI 318, Article 12.15.6.

5. Any additional Contractor-proposed splice shall be submitted for acceptance of location and splice length.

F. Lap welded wire reinforcement in accordance with Section 12.19 of ACI 318, but not less than the length of one mesh plus 2 inches.

G. Connection of reinforcement bars to steel shapes or plate shall be with a Cadweld Series B-splice.

H. Do not bend bars embedded in hardened or partially hardened concrete without approval from Engineer. If bending is permitted, conform to procedures of ACI 301 unless otherwise prescribed by the governing building code.

I. Do not weld reinforcing bars unless specifically indicated. Where welding is indicated, provide bars conforming to ASTM A706/A706M and comply with AWS D1.4.

END OF SECTION 03 2000

SECTION 03 3000 – CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes concrete and related items.

B. Related Work Specified Elsewhere:

1. Concrete Formwork: SECTION 031000.

2. Concrete Reinforcement: SECTION 032000.

3. Vapor Retarder: SECTION 031550.

4. Protective Coatings: SECTION 099000.

1.2 REFERENCED STANDARDS

A. Comply with the provisions of the following codes, specifications, and standards, except as otherwise indicated. Latest editions of the following shall be used, unless noted otherwise.

1. American Concrete Institute (ACI):
   a. 301 - Specifications for Structural Concrete.

   b. 318 - Building Code Requirements for Structural Concrete.

B. Applicable Standards Where Referenced Herein:

1. American Society for Testing and Materials (ASTM):
   a. A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. B370 - Copper Sheet and Strip for Building Construction.
   c. C31/C31M - Practice for Making and Curing Concrete Test Specimens in the Field.
   d. C33 - Concrete Aggregates.
   e. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   f. C40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
   g. C42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   h. C88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   i. C94 - Ready-Mixed Concrete.
   j. C114 - Test Methods for Chemical Analysis of Hydraulic Cement.
   k. C117 - Test Method for Material Finer than 75µ (No. 200) Sieve in Mineral Aggregates by Washing.
   l. C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   m. C142 - Test Method for Clay Lumps and Friable Particles in Aggregates.
   n. C143 - Test Method for Slump of Hydraulic Cement Concrete.
   o. C150 - Portland Cement.
   p. C172 - Practice for Sampling Freshly Mixed Concrete.

q. C192/C192M - Practice for Making and Curing Concrete Test Specimens in the Laboratory.
r. C231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
s. C233 - Test Methods for Air-Entraining Admixtures for Concrete.
t. C260 - Air-Entraining Admixtures for Concrete.
u. C289 - Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
v. C295 - Guide for Petrographic Examination of Aggregates for Concrete.
w. C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
x. C430 - Test Method for Fineness of Hydraulic Cement by the 45µ (No. 325) Sieve.
y. C494 - Chemical Admixtures for Concrete.
z. C566 - Test Method for Total Evaporable Moisture Content of Aggregate by Drying.
aa. C595/C595M - Blended Hydraulic Cements.
bb. C618 - Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
cc. C881 - Epoxy-Resin-Base Bonding Systems for Concrete.
dd. C1107 - Packaged Dry, Hydraulic Cement Grout (Nonshrink).
ee. C1193 - Guide for Use of Joint Sealants.
ff. C1315 - Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
gg. D1751 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).
hh. D1752 - Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
ii. D2240 - Test Method for Rubber Property - Durometer Hardness.
jj. E1155/E1155M - Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.

2. American Concrete Institute (ACI):
   a. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   b. 302.1R - Guide for Concrete Floor and Slab Construction.
   c. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
   d. 305R - Committee Report on Hot Weather Concreting.
   e. 306R - Committee Report on Cold Weather Concreting.
   f. 308.1 - Standard Specification for Curing Concrete.
   g. 309R - Guide for Consolidation of Concrete.

3. Concrete Plant Manufacturers Bureau (CPMB):
   a. 100 - Concrete Plant Standards.
   b. 102 - Recommended Guide Specifications for Batching Equipment and Control Systems in Concrete Batch Plants.
   c. Plant Mixer Manufacturers Division (PMMD) 100 - Concrete Plant Mixer Standards.

4. National Bureau of Standards (NBS) Specifications for Scales.
5. Truck Mixer Manufacturers Bureau (TMMB):
6. Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.

1.3 SUBMITTALS

A. Submit as specified in DIVISION 1.

B. Include, but not limited to, product data and Shop Drawings of the following:

1. Nonshrink grouts.

2. Admixtures.

3. Bonding agents.

4. Curing agents.

5. Concrete floor hardeners, sealers, and coloring compounds.

6. Expansion joint materials.

7. Joint sealants.

8. Waterstops.

C. Mill Certificates:

1. Submit to Engineer a minimum of one copy for each cement shipment.

D. Concrete Mix Design Proportions:

1. Submit as specified in PART 2, paragraph 2.01D - Mix Proportions, this Section.

2. Submit for each mix design, including aggregate gradation data.

3. Resubmit for any change in each mix design.

E. Production Test Reports: Submit as specified in DIVISION 1 and PART 2, paragraph 2.01E - Measurement of Materials, this Section

1.4 QUALITY ASSURANCE

A. Field Testing: Shall be performed by an ACI Concrete Field Testing Technician Grade 1.

B. Finishing: Finishing of concrete slabs and floors shall be supervised by an ACI Concrete Flatwork Technician/Finisher.

C. Submit qualification records of field testing and finishing technicians prior to placing concrete.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Materials:

1. Portland cement Type I, II, IP, or I/II shall conform to ASTM C150. Type IP shall conform to ASTM C595. Type IP shall not contain more than 25% pozzolan.

a. Fly ash shall be used as the pozzolan and be interground with the clinker in the manufacture of the cement. Fly ash shall conform to ASTM C618, Class F.

1) Fly ash may be added by Supplier as a separate ingredient provided the Supplier has scales for dispensing fly ash that meet the requirements of Paragraph 2.01.E, this Part.

b. The maximum amount retained on the No. 325 sieve shall be 10% as determined in accordance with ASTM C430.

c. The maximum amount of alkalies (NA2O + 0.658 K2O) shall be 0.60% determined in accordance with ASTM C114. A running average of three Samples shall not exceed a maximum of 0.50%.

d. Use one brand of cement throughout the Project unless otherwise approved by Engineer.

2. Fine Aggregate:

a. Conform to ASTM C33.

b. Conform to ASTM C33, except deleterious substances shall not exceed (by weight):

1) Clay Lumps: 0.25%.

2) Material Finer than No. 200 (75μ) Sieve: 2.0%.

3) Coal and Lignite: 0.07% except use sand containing not more than 0.05% coal and lignite when used in concrete for finished floor surfaces.

4) Other Deleterious Substances: 0.25%.

c. Approved service record of 3 years with a history indicating that the fine aggregate is not chemically reactive.

d. For a new fine aggregate source, or when 3 years' approved service records are not available, or when the service records are unacceptable; the aggregate shall be evaluated for potential reactivity. Aggregate must be considered innocuous in accordance with petrographic examination by ASTM C295 and tests conforming to ASTM C289.

e. Fine aggregate considered deleterious or potentially deleterious shall not be used without approval.

f. Maintain fine aggregate free of ice and frozen lumps.

g. Fineness modulus shall be between 2.3 and 3.1.

3. Coarse Aggregate:

a. Conform to ASTM C33.

1) Limits for deleterious substances and physical property requirements shall conform to Table 3 and applicable class designation 5S, 5M, or 1N.

b. Conform to ASTM C33 except deleterious substances shall not exceed the following percentages (by weight):

1)	Clay lumps and friable particles.....	1.0
2)	Shale or shale-like material.....	1.0
3)	Coal and lignite.....	0.05
4)	Material finer than No. 200 sieve.....	1.5
5)	Sum of all deleterious material.....	3.0

c. Approved service record of 3 years with a history indicating that the coarse aggregate is not chemically reactive.

d. For a new coarse-aggregate source, when 3 years' approved service records are not available, or when the service records are unacceptable; the aggregate shall be evaluated for potential reactivity. Aggregate must be considered innocuous in accordance with petrographic examination by ASTM C295 and tests conforming to ASTM C289.

e. Coarse aggregate considered deleterious or potentially deleterious shall not be used without approval.

f. Blast furnace slag will not be permitted.

g. Maintain coarse aggregate free of ice and frozen lumps.

h. Grading Requirements:
1) Size No. 57, from 1 inch to No. 4 sieve for all concrete unless otherwise specified

4. Mixing Water:
a. Only potable water will be acceptable.

5. Admixtures:
a. Water-Reducing Type:
1) Conform to ASTM C494, Type A.
2) Conform to manufacturer's recommendations for use.
3) Technical assistance of the manufacturer's field representative shall be furnished upon request.

b. Air-Entraining Type:
   1) Conform to ASTM C260.
   2) Conform to manufacturer's recommendations for use.
   3) Technical assistance of the manufacturer's field representative shall be furnished upon request.
   4) Testing of air-entraining admixtures shall conform to ASTM C233.

c. Other Admixtures: Use only with Engineer's written concurrence.
   1) Water-Reducing, Retarding Type: Conform to ASTM C494, Type D.

d. Admixtures shall not contain any chloride ions.

e. Storage: Admixtures shall be stored in such a manner as to avoid contamination, evaporation, freezing, temperature changes, settling, or any damage which would adversely affect their characteristics.

B. Laboratory Testing of Materials for Use in Concrete:

1. Owner shall engage an independent testing laboratory to perform all required laboratory tests of materials proposed for use in the production of concrete and to determine mix proportions when laboratory trial batches are required.

2. Contractor shall deliver representative Samples of all proposed concrete materials to the laboratory for the following testing:

   a. Fine Aggregate:

      1) ASTM C33 (as amended by PART 2, paragraph 2.01A. - Materials, this Section).

      2) ASTM C40.

      3) ASTM C88.

      4) ASTM C117.

      5) ASTM C136.

      6) ASTM C142.

      7) Fineness modulus.

      8) ASTM C295 and ASTM C289 or approved service records.

   b. Coarse Aggregate:

      1) ASTM C33 (as amended by PART 2, paragraph 2.01A. - Materials, this Section).

      2) ASTM C88.

3) ASTM C136.

4) ASTM C142.

5) ASTM C295 and ASTM C289 or approved service records.

c. Air-entraining admixture shall be tested conforming to ASTM C233.

3. The laboratory test results shall be part of the design mix submittal specified in this PART 2, paragraph 2.01D. - Mix Proportions.

C. Concrete Qualities Required by Location:

1. Foundations and Exterior Concrete Paving:
   a. Minimum 28-day compressive strength = 4,000 psi
   b. Air entrainment = 6% + 1.5%
   c. Slump = 2 to 4 inches
   d. Water-Cement Ratio = 0.42

2. Slab on Grade and Elevated Slabs (except roof and roof topping)
   a. Minimum 28-day compressive strength = 4,000 psi
   b. Air entrainment = 3% max
   c. Slump = 2 to 4 inches
   d. Water-Cement Ratio = 0.42

3. Elevated Roof Slab and Roof Topping Slab
   a. Minimum 28-day compressive strength = 4,000 psi
   b. Air entrainment = 6% $\pm$ 1.5% max
   c. Slump = 2 to 4 inches
   d. Water-Cement Ratio = 0.40

4. Lean Concrete Fill
   a. Minimum 28-day compressive strength = 2,000 psi
   b. Air entrainment = 3% $\pm$ 1.5% max
   c. Slump = 2 to 4 inches
   d. Water-Cement Ratio = 0.45

5. Compressive-strength determinations shall be made from 6-inch diameter x 12-inch long concrete cylinders tested in accordance with ASTM C39.

6. Slump of concrete shall be tested in accordance with ASTM C143.

7. Air content shall be tested in accordance with ASTM C231.

D. Mix Proportions:

1. Concrete shall be homogeneous, readily placeable, uniformly workable, and finishable; proportioned to conform to ACI 211.1.

2. Mix proportions for all concrete, unless otherwise specified, shall be selected preferably on the basis of field experience; but in the case where sufficient or suitable strength test data is not available, concrete shall be proportioned on the basis of laboratory trial mix design.

    a. Field experience using test results within the preceding year, with the materials and plant to be employed may be the basis of mix proportioning, provided that not less than 30 consecutive satisfactory compressive-strength tests on concrete using the proposed materials with a similar mix are available. A compressive-strength test is defined as the average 28-day compressive strength of two companion cylinders made conforming to ASTM C172 and ASTM C31 and tested conforming to ASTM C39.

    b. The standard deviation of compressive-strength tests shall be computed as a basis for design of the mix. The design average compressive strength shall exceed the specified strength by at least:

        1) 400 psi if standard deviation is less than 300 psi.

        2) 550 psi if standard deviation is 300 to 400 psi.

        3) 700 psi if standard deviation is 400 to 500 psi.

        4) 900 psi if standard deviation is 500 to 600 psi.

        5) 1,200 psi if standard deviation is greater than 600 psi.

3. Submit the following test data to Engineer for approval prior to placing concrete:
    a. Fine Aggregate:

        1) ASTM C33.

        2) ASTM C40.

        3) ASTM C88.

        4) ASTM C117.

        5) ASTM C136.

        6) ASTM C142.

        7) Fineness modulus.

        8) ASTM C295 and ASTM C289 or approved service records.

    b. Coarse Aggregate:

        1) ASTM C33.

2) ASTM C88.

3) ASTM C136.

4) ASTM C142.

5) ASTM C295 and ASTM C289 or approved service records.

c. Cement:

1) Mill certificate.

2) ASTM C430.

d. Concrete:

1) Fine and coarse aggregate, water and cement sources.

2) Mix proportions, slump and air content.

3) Data on 30 consecutive satisfactory compressive strength tests and standard deviation calculations.

4. Laboratory Trial Batch: When laboratory trial batches are used as a basis for determining mix proportions, all such Work shall be performed by the laboratory as specified in PART 2, paragraph 2.01B. - Laboratory Testing of Materials for Use in Concrete, this Section.

a. Laboratory trial batches shall be used to establish a water-cement ratio, compression-strength curve with at least three points, each representing the strength of a separate trial batch. At least one point shall be above and one below the strength required. Each point on the curve shall represent the average of at least three cylinders tested at 28 days or an earlier age when approved by Engineer. The slump and air content shall be at the maximum limits specified in PART 2, paragraph 2.01C. - Concrete Qualities Required, this Section.

b. A point on the water-cement ratio, compressive-strength curve shall be selected that will provide an average compressive strength at least 1,200 psi greater than the specified minimum strength.

c. Submit the following test data to Engineer for approval prior to placing concrete.
1) Fine Aggregate:

a) ASTM C33.

b) ASTM C40.

c) ASTM C88.

d) ASTM C117.

e) ASTM C136.

f) ASTM C142.

g) Fineness modulus.

h) ASTM C295 and ASTM C289 or approved service records.

2) Coarse Aggregate:

a) ASTM C33.

b) ASTM C88.

c) ASTM C136.

d) ASTM C142.

e) ASTM C295 and ASTM C289 or approved service records.

3) Cement:

a) Mill certificate.

b) ASTM C430.

4) Concrete:

a) Fine and coarse aggregate, water and cement sources.

b) Laboratory mix proportions, slump and air content.

c) Water-cement ratio, compressive-strength curve.

d) Water-cement ratio, flexural-strength curve.

d. Prior to placing any concrete, the testing laboratory shall report the results of the testing and mix designs to the following:

1) Engineer, St. Louis Office (one copy).

2) Resident Project Representative, Field Office (one copy).

3) Contractor (copies as required).

4) Concrete Supplier (copies as required).

e. Measurement of Materials:

1) General Requirements:

a) Conform to ACI 304R.

b) Beam or springless dial-type scale conforming with NBS - "Specifications for Scales."

c) Volumetric measurement of water shall be performed with an approved automatic valve.

2) Concrete Plant Scale Accuracy and Calibration Frequency:

a) The concrete plant scales shall be accurate to +0.4% of the capacity of the scale.

b) The scales shall be calibrated at intervals as specified in PART 3, ARTICLE 3.09 -TESTING, this Section.

3) Individual Batch Accuracy:

a) Cement: +1.0%.

b) Water: +1.0% by volume or weight.

c) Aggregates: +2.0%.

d) Admixtures: +3.0% by volume or weight.

e) Fly Ash: ±1.0%.

5. Mixing and Delivery:

a. Conform to ACI 304R.

b. Cement temperature, when added to mix, shall not exceed 170°F (77°C).

c. Adjust the amount of mix water to compensate for the moisture content of the aggregates.

d. Concrete Plant:

1) Conform to "Concrete Plant Mixer Standards" of the Plant Mixer Manufacturers Division, Concrete Plant Manufacturers Bureau, and "Concrete Plant Standards" of the Concrete Plant Manufacturers Bureau.

2) Charge with 5% to 10% of the mixing water both in advance and after the addition of aggregates and cement.

3) Charge with remaining water uniformly with the other materials.

4) Avoid charging in excess of manufacturer's rating.

5) Discharge mixed concrete completely prior to recharging.

6) Mixing Time:
   a) Start immediately when all ingredients, except the last of the water, are in the mixer.

   b) Minimum mixing time shall conform with mixer manufacturer's instructions, but not be less than the following:

Capacity of Mixer Cubic Yards	Minimum Time of Mixing
1 or less	1 minute
2	1 minute, 15 seconds
3	1 minute, 30 seconds
4	1 minute, 45 seconds
5	2 minutes
6	2 minutes, 15 seconds

Add 15 seconds' mixing time for each additional cubic yard of concrete.

7) Mix concrete in central mixer or truck mixer. Transport in truck mixer turning at agitation speeds only.

8) Water added to concrete having a slump below the specified minimum shall be at Contractor's risk. If the water added produces a slump greater than the specified maximum, the concrete will be rejected. If water is added, the concrete shall be remixed for a minimum of 25 revolutions. Water shall not be added after the truck mixer has begun to discharge concrete.

9) Truck mixer shall conform to "Truck Mixer, Agitator, and Front Discharge Concrete Carrier Standards" of the Truck Mixer Manufacturers Bureau.

10) Ready-mixed concrete shall be produced and delivered conforming to ASTM C94 as applicable.

11) Contractor shall furnish Owner with a concrete delivery ticket for each load of concrete. The ticket shall have the following information recorded:

   a) Serial number of ticket.

b) Time batched.

c) Time arrived on jobsite.

d) Amount of concrete (by volume).

e) Mix number.

f) Amount of all water added at jobsite by Contractor.

g) Name of ready-mix batch plant.
h) Date.

i) Truck number.

j) Name of purchaser.

e. Plant and truck mixer uniformity shall be tested according to ASTM C94. Frequency of tests shall be as specified in PART 3, this Section.

2.2 GROUT

A. Grout for Dry Packing:

1. Volume: 1 part portland cement to 2 parts sand.

2. Keep water to a minimum as required for placing by the dry packing method.

3. Place after the mixed grout has been allowed to stand for 2 hours.

4. The sand and cement shall be as specified for concrete.

B. Flowable Nonshrink Grout:

1. Required for setting handrail posts, for setting equipment recommended by the manufacturer to be set with nonshrinking grout, and in other places indicated.

2. Grout shall be nonmetallic and conform to ASTM C1107.

3. Prepare and place conforming to manufacturer's printed instructions.

4. For equipment bases, the concrete surfaces shall be grit blasted or roughened with a chipping hammer prior to grouting. The foundation plates shall be cleaned of any grease, oil, paint, primers, or epoxy coatings.

C. Grout for Bonding:

1. Proportion (by weight): 1 part cement to 1-1/2 parts sand.

2. Keep water to a minimum.

2.3 BONDING AGENT

A. Provide moisture-insensitive, epoxy-resin bonding agent conforming to ASTM C881, Type V.

2.4 CONCRETE ACCESSORIES

A. PVC Waterstops:

1. 6-inch ribbed serrated virgin polyvinyl chloride equal to one of the following:

a. Greenstreak, Inc. - Greenstreak Style 679.

b. Vinylex Corporation - R6-38.

c. Southern Metals - 17FR.

2. Base Seal: Virgin polyvinyl chloride equal to one of the following:

a. Nonexpansion Joints:

1) Greenstreak, Inc. - Greenstreak Style 771.

2) Vinylex Corporation - BS9-532.

b. Expansion Joints:

1) Greenstreak, Inc. - Greenstreak Style 772.

2) Vinylex Corporation - BSE9-532.

3. Provide factory fabricated waterstop corner transitions and intersections leaving only straight butt joint splices for the field.

4. Waterstops shall be provided with factory-installed hog rings at 12-inch centers along each flange.

5. Use for all locations unless otherwise specified.

B. Expansion Joints:

1. Expansion Joint Filler: Premolded cork of thickness indicated and conforming to ASTM D1752, Type II, cork. Unless indicated to be asphalt-impregnated fiber.

2. Expansion Joint Filler: Preformed asphalt-impregnated fiber of thickness indicated and conforming to ASTM D1751. Use where indicated.

3. Bond Breaker: Polyethylene tape or other plastic tape as recommended by sealant manufacturer.

4. Sealant Backer Rod: Provide closed cell backer rod or other backing material as recommended by sealant manufacturer.

5. Joint Sealants:
   a. Multi-component sealant as follows:

      1) Joint Sealant - General Use:

         a) BASF Building Systems: Sonneborn Sonolastic NP 2 (vertical use) and Sonolastic SL 2 (horizontal use).

         b) Epoxy Systems Products Company: Product #11.

         c) Euclid Chemical Company: Eucolastic II.

         d) Pecora Corporation: NR-200, Dynatred.

      2) Joint Sealant - Industrial Floors (Shore A hardness ≥80):

         a) BASF Building Systems: Sonneborn TF-100.

         b) Euclid Chemical Company: EUCO 800.

C. Preformed Contraction Joints: Zip Joint T-shaped plastic strip as manufactured by BoMetals, Inc., Powder Springs, Georgia. Depth of preformed construction joint shall exceed 1/4 of the slab thickness.

2.5 CURING AGENT

A. Apply to all concrete surfaces unless otherwise indicated or specified.

B. Curing agent shall conform as follows:

1. ASTM C309, Type 1: Use where concrete surface is not exposed to direct sunlight after placement.

2. ASTM C309, Type 1-D: Use where slabs are exposed to direct sunlight for a period of seven days minimum after placement. Curing and sealing agent with fugitive dye shall be readily distinguishable upon the concrete surface for at least four hours after application but shall be inconspicuous within seven days after application.

3. ASTM C309, Type 2: Use as specified in PART 3, ARTICLE 3.05 - HOT WEATHER CONCRETING, this Section.

C. Curing compound used on floors to be sealed, painted, tiled, topped, dampproofed, waterproofed, or covered with resilient floor covering shall be guaranteed not to interfere with application of sealer, paint, tile mortar, or tile adhesive after a 28-day curing period.

D. Curing compound shall be VOC compliant with a maximum VOC content of 2.9 lbs/gal, or less where Project location regulations are more stringent.

2.6 CONCRETE FLOOR CURING AND SEALING AGENT

A. Apply to all interior concrete floor surfaces subject to vehicle or pedestrian traffic.

B. Curing and sealing agent shall conform as follows:

1. ASTM C1315, Type I, Class A: Use where slabs are not exposed to direct sunlight after placement.

2. ASTM C1315, Type I, Class A with Fugitive Dye: Use where slabs are exposed to direct sunlight for a period of seven days minimum after placement. Curing and sealing agent with fugitive dye shall be readily distinguishable upon the concrete surface for at least four hours after application but shall be inconspicuous within seven days after application.

3. ASTM C1315, Type II, Class A: Use as specified in PART 3, ARTICLE 3.05 - HOT WEATHER CONCRETING, this Section.

C. Apply as soon as possible and in conformance with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION FOR CONCRETE PLACEMENT

A. Openings Through Concrete: Provide openings through concrete as indicated and for the proper installation of all equipment, piping, wiring, ductwork and similar items, installed under this Contract.

B. Installation of Embedded Items:

1. Provide for accurate installation of embedded items installed under this Contract.

2. Securely fix floor drains in place to prevent flotation while placing concrete. Uniformly and accurately slope finish floor slab toward the drains.

3. Embedded items shall be as indicated or specified, or as selected by Contractor and approved by Engineer.

4. During cold weather, protect pipe sleeves from moisture which may freeze, expand, and crack the sleeve and concrete structure.

5. Grease or tape anchor bolt threads to protect from concrete splatter.

6. All accessories touching the exposed surface of the concrete or come in contact with soil shall be coated with plastic or epoxy to prevent rust.

C. Installation of Joints:

1. Construction Joints:

   a. Location:
      1) Locate joints, which are not indicated or specified, in conformance with ACI 318.

      2) Locate joints to limit the length of all concrete placements to not more than 16 feet or as indicated on contract drawings.

      3) Obtain Engineer's approval of joints located by Contractor prior to preparation of reinforcing steel drawings.

   b. Preparation and Installation:

      1) Clean and break laitance or other foreign material from bonding surface.

      2) Tighten forms remaining in place (where applicable) to prevent seepage between forms and hardened concrete.

      3) Provide waterstops and shear keys as indicated or specified and as required in any new construction joint requested by Contractor.

   c. Waterstops:

      1) Install in all construction joints where indicated.

      2) Install conforming to manufacturer's printed instructions. All joints and splices of PVC waterstop shall be 100% fused. Use thermostatically controlled splicing iron as recommended by manufacturer.

2. Expansion Joints:

   a. Install filler, backer rod and sealant in strict conformance with manufacturer's written instructions.

   b. Reinforcing steel shall not extend through expansion joints unless indicated otherwise.

   c. Attach rigid joint filler to the face of the joint prior to placing adjacent concrete. The filler shall occupy the entire width of the joint.

   d. Install sealant backer rod for sealant except where indicated to be omitted. Install bond breaker where indicated.

   e. Clean joints surfaces immediately before application of sealant.

   f. Install joint sealants to conform to ASTM C1193. Tool sealants to provide smooth, uniform bead with a slightly concave surface, eliminate air pockets, and insure sealant contact and adhesion with sides of joint.

g. Protect joints from moisture and ice during freezing.

3. Contraction Joints: As specified in this PART 3, ARTICLE 3.03 - FINISHING, this Section.

D. Cutting and Bonding to Existing Concrete:

1. Cutting Existing Concrete:

a. Use methods and equipment that will avoid damage to adjacent parts of the structure from heavy blows or vibration.

b. Cut existing concrete with power concrete saw where possible to prevent spalling and chipping and to form neat, straight edge.

c. Remove all loose or cracked concrete resulting from cutting existing concrete, leaving only sound, undamaged concrete adjacent to new Work.

d. Leave access opening edges with a neat, true grout surface to the opening size indicated.

e. Cut reinforcing steel with sufficient length remaining (approximately 38 bar diameters) for bending and lapping into new construction.

2. Bonding to Existing Concrete:

a. Roughen concrete to 1/4-inch (6 mm) amplitude by use of a pneumatic chipping hammer or other approved means.

b. Thoroughly clean the concrete surface and apply the bonding agent in accordance with manufacturer's written instructions.

3.2 PLACING OF CONCRETE

A. Conventional Placing:

1. General Requirements:

a. Conform to ACI 304R.

b. Bonding surfaces, including reinforcement, shall be clean, free of laitance and foreign materials.

c. Face horizontal bonding surfaces with 1-inch (25-mm)-thick coat of fresh "grout for bonding." Wet all other surfaces.

d. Place concrete on properly prepared and unfrozen subgrade and only in dewatered excavation and forms.

e. Use forms for all concrete except where otherwise indicated or specified. (Footings entirely below grade may be earth formed.)

f. Do not place concrete that has partially hardened or has been contaminated by foreign materials.

g. Prevent mud or foreign materials from entering the concrete or forms during placement operations.

2. Conveying:

a. Convey concrete from the mixer and deposit in place by methods which will prevent the segregation or loss of materials.

b. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to provide a practically continuous flow of concrete at the delivery end.

c. Aluminum conveying equipment shall not be used.

3. Depositing:

a. Place concrete in continuous horizontal lifts not to exceed 2 feet, and place concrete against bulkheads and keyways at vertical joints.

b. Maximum free drop of concrete and grout for bonding shall be 5 feet, in walls 10 inches or less in thickness, with 1-foot additional drop allowed for each inch of wall thickness over 10 inches, with a maximum drop of 10 feet.

c. When vapor barrier is used, keep lapped joints closed and take precautions to avoid puncturing the barrier.

4. Consolidation of Concrete:

a. Consolidate concrete in conformance with ACI 309R. Characteristics and application of concrete vibrators shall be as set forth in Table 5.1.5.

b. Provide an adequate number of vibrators of sufficient capacity to keep up with the maximum rate of concrete placement. Keep on hand adequate standby equipment in good operating condition.

c. Vibrate concrete only until the concrete is thoroughly consolidated and the voids filled, as evidenced by the leveled appearance of the concrete at the exposed surface and the embedment of the surface aggregate.

d. Insert internal vibrators vertically to the full depth of the layer being placed and into the previous layer. Do not drag vibrators through the concrete. Insert and withdraw vibrator slowly with the vibrator running continuously so that no hole will be left in the concrete. Do not flow concrete from one location to another by use of a vibrator.

e. Consolidate concrete layer to full depth when using a surface vibrator. Use thinner layers or a more powerful vibrator if necessary to achieve complete consolidation.

f. Use form vibrators only where sections are too thin or where sections are inaccessible for internal vibrators.

5. Time Requirements:

a. Place concrete at a sufficient rate to assure that lifts below have not taken initial set before fresh concrete is deposited.

b. Place concrete within 45 minutes after mixing. This period may be extended to 1 hour and 30 minutes provided that the combined air temperature, relative humidity, and wind velocity are such that the plasticity of the fresh concrete is satisfactory for placement and consolidation, and that the specified mixing water is not exceeded. Concrete which has partially set shall not be retempered but shall be discarded.

B. Placing Concrete at Joints:

1. Bed horizontal joints with 1 inch of grout for bonding.

2. Take precautions to ensure tight, well-bonded construction joints with no air pockets or voids.

3. Take special precautions to avoid bending or displacing waterstop while placing concrete around it.

4. Delay construction at a joint a minimum of 16 hours where placement is continued past joint, except where otherwise indicated.

3.3 FINISHING

A. Unformed Surfaces:

1. Screed Finish:

a. Use as first stage for all concrete finishes.

b. Use as final finish on surfaces that will be covered by additional concrete, grout placement, or mortar setting bed except as otherwise specified.

c. Immediately after screeding, use a wood float, darby, or bullfloat to eliminate high and low spots and to embed large aggregate. This shall be done in a manner to produce even, uniform surfaces so that surface irregularities do not exceed 3/8 inch in 10 feet when used as final finish.

2. Floated Finish:

a. Use as second stage of broomed or troweled finish.

b. Use as final finish on all areas to receive built-up roofing, quarry or ceramic tile with mortar setting bed, and for tops of footings and other surfaces that will be buried.

c. Float with mechanical float. Hand floating will be permitted only in areas inaccessible to mechanical float.

d. On surfaces not to receive troweled finish, finish with wood or cork float after mechanical floating to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet, except at floor drains.

3. Broomed Finish:

a. Use as final finish on all outdoor slabs including pavements, sidewalks, and equipment pads.

b. After floated finish, draw a stiff bristle broom across the surface making uniform corrugations, perpendicular to the direction of traffic, not more than 1/16 inch deep.

4. Troweled Finish:

a. Use as final finish on inside floors and on all other unformed surfaces not otherwise indicated or specified.

b. Trowel with mechanical steel trowel to obtain a smooth, dense finish. Hand steel trowel shall be used in areas not accessible by mechanical trowel. The final troweling shall be done after the concrete has become hard enough so that no mortar adheres to the edge of trowel and a ringing sound is produced as the trowel passes over the surface.

c. Do not trowel before surface water has evaporated or has been removed with a squeegee.

d. Finish to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet, except at floor drains.

e. Do not add sand or cement to the floor surface.

5. Contraction Joints:

a. Locate as indicated.

b. Maintain true alignment with straightedge.

c. Joints shall be grooved except where sawed joints are indicated.

1) Slab on grade joints shall be sawed.

d. Grooved Joints:

1) Perform during the finishing process.

2) Width of groove shall not exceed 1/4-inch.

3) Depth of groove shall be at least 1 inch.

e. Sawed Joints:

1) Cut joints with power blade as soon as concrete surface is firm enough to resist tearing or damage by the blade and before random shrinkage cracks can occur. (Usually required 4 to 12 hours after finishing.)

2) Make joints approximately 1/8 inch wide with depth equal to 1/4 the slab thickness unless otherwise indicated.

3) Seal where indicated with the same type sealant specified for expansion joint sealant.

B. Formed Surfaces:

1. Repair surface defects as specified in PART 3, paragraph 3.03C. - Repair of Defective Surfaces, this Section.

C. Repair of Defective Surfaces:

1. Defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb, or any other defective area.

2. Repairing:

a. Repair as soon as forms have been removed.

b. Chip surface back to minimum depth of 1/2 inch, chip edges perpendicular to surface, prewet depression and brush with neat cement immediately before patching.

c. Patch surfaces using stiff mortar with same sand-cement ratio as original concrete and with minimum water for placing. Blend with white cement to match concrete color.

d. Compact mortar into depressions so that after curing, hole is filled and mortar is flush with surface. Use hammer and ramming rod for compacting the holes.

e. Moist-cure for 3 days or use curing compound.

f. Engineer shall be notified of areas containing defects or where reinforcing steel is exposed, prior to determination of repair method.

3.4 CURING

A. Cure concrete by one of the following methods in accordance with ACI 308.1:

1. Leaving in forms for a minimum of 7 days. Keep formwork wet to prevent drying of concrete surfaces.

2. Use of saturated bats, soaker hoses, or sprinkler for a minimum of 7 days. Keep concrete continuously wet.

3. Using polyethylene sheets applied in full contact with surfaces.

4. Using one coat of a liquid membrane forming compound as specified. Apply immediately after removal of forms (which have been continuously wet); or in case of a slab, after the concrete has been finished and is hardened sufficiently to walk on.

5. Curing of concrete during hot or cold weather shall conform to PART 3 - HOT WEATHER CONCRETING and COLD WEATHER CONCRETING, this Section.

3.5 HOT WEATHER CONCRETING

A. Follow the recommendations of ACI 305R if any of the following conditions occur:

1. When the temperature is 90^{o}F or above.

2. When the temperature is likely to rise above 90^{o}F within the 24-hour period after concrete placement.

3. When there is any combination of high air temperature, low relative humidity, and wind velocity which would impair either concrete strength or quality.

B. Concrete shall have a maximum temperature of 85^{o}F during placement.

C. Dampen subgrade and forms with cool water immediately prior to placement of concrete.

D. Protect freshly placed concrete immediately after placement so that the rate of evaporation as determined by ACI 305R (Figure 2.1.5) does not exceed 0.2 pound per square foot per hour.

E. Protect concrete with suitable insulation if rapidly decreasing nighttime temperatures occur, which would cause thermal shock to concrete placed during warm daytime temperatures.

F. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.

G. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water-saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After the 24-hour interval, continue curing using one of the following methods:

1. Moist curing for 6 days.

2. Application of one coat of curing compound as specified.

3. Application and maintenance of curing paper or heat-reflecting plastic sheets for 6 more days.

H. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing using one of the following methods:

1. Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for 6 days.

2. Strip forms and apply curing compound as specified. Do not allow concrete surfaces to dry prior to application of curing compound.

3.6 COLD WEATHER CONCRETING:

A. When the temperature is 40°F or is likely to fall below 40°F during the 24-hour period after concrete placement, follow the recommendations of ACI 306R to prevent loss of concrete strength or quality.

B. Minimum temperature for concrete as mixed shall be as indicated on lines 2, 3, and 4 of Table 3.1 of ACI 306R. Maximum temperature for concrete as mixed shall be 10°F greater than the corresponding minimum temperature.

C. Place and maintain concrete so that its temperature is never less than the temperature indicated on line 1 of Table 3.1 of ACI 306R. Maintain the required temperature for the time duration indicated on Tables 5.1 and 5.3 of ACI 306R.

D. Monitor temperature of concrete in place at corners or edges of formwork as applicable.

E. Air Heaters:

1. Do not expose concrete to carbon monoxide or carbon dioxide fumes from heaters or engines.

2. Oil- or coke-burning salamanders will not be permitted.

3. Heaters shall be ultramatic portable heaters made by the Union Chill Mat Company or Engineer approved equal.

4. Personnel shall be present at all times to maintain safe, continuous operation of heating system.

F. Control temperature and humidity of protected concrete so that excessive drying of concrete surfaces does not occur.

G. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen subgrade prior to concrete placement.

H. The maximum allowable temperature drop during the first 24-hour period after protection is discontinued shall be as indicated on Table 5.5 of ACI 306R.

I. Cure the concrete in accordance with Chapter 5 of ACI 306R.

3.7 LOW-STRENGTH CONCRETE:

A. Low-Strength Concrete:

1. Defined as either:

a. Concrete whose average, of any sets of three consecutive 28-day compressive strength tests, is below the required 28-day strength.

b. Concrete whose individual 28-day strength test (average of two cylinders) is more than 500 psi below the required 28-day strength.

2. Should concrete meet either definition of low-strength concrete as a minimum, the Contractor shall take the following steps:

a. Increase the cement content. The increase shall be based on a statistical evaluation of the strength data, the design water-cement ratio, compressive-strength curve, and acceptable mix-design literature as follows:

1) If sufficient concrete has been furnished to accumulate 30 tests, these should be used to establish a new target average strength in accordance with ACI 318, Section 5.3.

2) If less than 30 tests have been made, the new target average strength should be at least as great as the average strength used in the initial selection of the mix proportions. Increase the target average strength based on a statistical evaluation of the available strength data, the design water-cement ratio, compressive-strength curve, and acceptable mix-design literature. If the statistical average equals or exceeds the initial mix-design level, a further increase in the average level is required.

b. Remove and replace with acceptable concrete when the quality and location of the low-strength concrete is such that Engineer considers the strength or durability of the structure is impaired and so orders.

3. Low-strength concrete shall be considered defective Work as defined in GENERAL CONDITIONS.

B. Potentially Low-Strength Concrete: Defined as concrete whose 7-day test (average of two cylinders) is less than 70% of the specified minimum 28-day compressive strength.

C. Construction delays caused by low-strength or potentially low-strength concrete shall not relieve Contractor from responsibility for late completion even though extensions of time may be granted.

3.8 MISCELLANEOUS CONCRETE ITEMS:

A. Equipment Bases:

1. Construct equipment bases, pads, and foundations as indicated or, when not indicated, conforming to equipment manufacturer's requirements.

2. Reinforce conforming to typical detail unless otherwise indicated.

3. Equipment bases shall include concrete, reinforcing steel, form work as required, and anchor bolts. Place grout for equipment installed under this Contract.

4. Where quarry tile is required as a finish, leave concrete float- finished for bonding to tile.

5. Finish top area of bases between anchor bolts and forms with a troweled finish.

3.9 TESTING:

A. Field Testing of Concrete Plant and Mixing Trucks:

1. The concrete plant shall be inspected and tested to ensure conformance with ACI 304R and the "Concrete Plant Standards of the Concrete Plant Manufacturers Bureau." The scales shall be calibrated at the initial setup and at 3-month intervals thereafter.

2. Mixing trucks shall be inspected and tested to ensure conformance with ACI 304R and "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau" of the National Ready-Mix Concrete Association. Tests shall be done at initial setup and every 3 months thereafter.

3. Submit test reports when requested.

B. Field Testing of Concrete and Making of Concrete Test Cylinders:

1. Contractor shall furnish test equipment, test cylinder molds, and certified personnel to perform all required field tests, make the required concrete test cylinders, and deliver test cylinders to the testing laboratory. The prescribed tests shall be made in the presence of or with the concurrence of the Owner.

2. Field testing personnel shall be on Site throughout placement of concrete.

3. Concrete sampling for tests and cylinder making shall be done conforming to ASTM C172. Samples shall be taken at random and at the point of truck discharge.

4. Perform the following tests:

a. Moisture content, ASTM C566. Perform this test a minimum of twice a day and adjust the amount of mix water to compensate for the moisture content of the aggregates.

b. Prepare test cylinders conforming to ASTM C31, with not less than one set of four cylinders from each day's placement for each 100 cubic yards or fraction thereof.

c. Slump test conforming to ASTM C143. Perform tests on the first batch produced each day, for every 50 cubic yards or fraction thereafter, and with every set of test cylinders. Additional tests shall be run when directed by Engineer.

d. Air content test conforming to ASTM C231. Perform for first batch of day and with each set of test cylinders.

e. The batch of concrete being tested for slump or air content shall not be placed until acceptable results are obtained.

f. Discard concrete used for slump and air tests.

g. Perform concrete and air temperature tests for first batch of day and with each set of test cylinders. Additional readings shall be taken when directed by Engineer.

h. Any batch of concrete with slump or air content not in conformance with Specifications shall be rejected.

i. Furnish slump, air content, and temperature test results to the testing laboratory for inclusion in the cylinder test reports.

j. Prepare test cross-section beams conforming to ASTM C78 with not less than one set of test beams for testing laboratory.

C. Laboratory Testing of Aggregates and Concrete During Construction:

1. An independent testing laboratory will be selected and paid by the Owner to perform the required laboratory tests and statistical evaluations of aggregates and concrete being used in the Work.

2. Laboratory will cure and test concrete cylinders conforming to ASTM C192 and C39, testing two cylinders at 7 days of age and two at 28 days of age.

3. Contractor shall have the right to observe all phases of concrete cylinder curing and testing. Should Contractor observe any deviations from the prescribed testing procedures that he considers detrimental to concrete strength test results, he shall immediately notify Owner in writing.

4. Contractor shall assist laboratory in obtaining Samples of fine and coarse aggregate for testing.

5. Contractor shall make arrangements with the testing laboratory to receive copies of test reports. The cost of providing a maximum of two copies of each report to the Contractor will be paid by Owner.

6. Should the test results indicate low strength concrete as defined in PART 3, ARTICLE 3.07 - LOW-STRENGTH CONCRETE, this Section, Contractor shall take immediate corrective action.

7. Should the statistical data indicate an excessive margin of safety, the concrete mix may be modified subject to Engineer's approval.

8. Should the material tests taken during construction indicate nonconformance with the Specifications, Contractor shall take immediate corrective action.

3.10 REPAIR, REPLACEMENT, AND FIELD MODIFICATIONS:

A. Embedded items and concrete that are misplaced or damaged during construction shall not be repaired, replaced, or field-modified without approval of Engineer.

END OF SECTION 03 3000

SECTION 09 900 – PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes coating 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 are generally not required to have finish-coats unless otherwise specified, but prime coat should be applied and touched up prior to concealment.

4. Where Equipment and Materials are provided with shop-applied finished coating system, only (touch-up is) (touch-up and finish coats are) a part of field painting.

5. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.

C. Color:

1. Color of finish coatings shall match accepted color Samples.

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.

1.2 RELATED DOCUMENTS

A. Shop Painting and Coatings; All applicable Divisions.

B. Factory Prefinished Items: All applicable Divisions.

C. Clear Concrete Floor Sealer – See SECTION 033000 CONCRETE.

1.3 REFERENCED STANDARDS

A. Applicable Standards:

1. American National Standards Institute (ANSI):
   a. Z53.1 - Safety Color Code for Marking Physical Hazards.

2. American Society for Testing and Materials (ASTM):
   a. D2092 – Guide for Treatment of Zinc-Coated (Galvanized) Steel Surfaces for Painting.
   b. D4258 - Surface Cleaning Concrete for Coating.
   c. D4259 - Abrading Concrete.
   d. D4260 - Acid Etching Concrete.
   e. 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 nine square inches 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 nine square inches 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.

1.4 SUBMITTALS

A. Submit as specified in DIVISION 1.

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. Sample panels, two approximately 4" x 8" (100mm x 200 mm), of selected colors for all systems.

5. 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.

6. 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.

C. Submittals for industrial maintenance coatings shall be prepared by, or have assistance in preparation of, a corrosion engineer or industrial coatings technical representative of the coating manufacturer.

1.5 QUALITY ASSURANCE

A. Certification: Coating work shall be performed by an SSPC certified contractor having a minimum of Category QP 1 certification for work without hazardous paint removal, and Category QP 2 certification for work involving hazardous paint removal.

B. 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.

C. Sampling of Materials:

1. All materials to be used will be subject to testing for compliance with Specifications.
2. Owner will provide testing.

D. Prepainting Conference:

1. Before Project field painting starts, representatives for the Owner, Contractor, coating applicator, and coating manufacturer's technical representative shall meet with Engineer/Architect.

2. Agenda for the meeting will include details of surface preparations and coating systems to ensure understanding and agreement by all parties for compliance.

E. 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.

F. 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.

1.6 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.

1.7 REGULARTORY 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) (are totally lead free except for zinc-rich primers which shall not have a lead content over 0.06% by weight of nonvolatile content).

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.

1.8 PROJECT CONITIONS

A. This Project is located within a coal-fired power generation facility. Coal storage is present on the Site which results in coal dust being blown throughout the exterior areas. Take precautions

to protect shop prime-coated surfaces during storage or between field-applied coats to prevent deterioration of the coatings through chemical reaction or embedment of coal dust into the coating. If coal dust accumulates on or deteriorates the prime coating, coating manufacturer shall assess the situation and make recommendations for cleaning, surface preparation, and repriming, if necessary. Contractor shall perform required Work and assume costs involved.

B. This Project contains some structures of a height in which drifting coatings, if spray-applied, could contaminate adjacent building surfaces or vehicles on nearby roadways. All containment precautions and application methods shall be taken into consideration and implemented to prevent the above from occurring.

C. This Project is in the vicinity of aircraft runways; consequently, jet fuel residue from aircraft frequently drifts from aircraft upon take-off and landing. Wind conditions are also created which could cause grit and dust to be blown around the area. All precautions and protection of surfaces shall be taken to prevent grit and dust embedment into freshly painted surfaces.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Proprietary names and product numbers are specified in most systems for material identification from these manufacturers:

1. Ameron Protective Coatings Systems Group, Ameron Corp.

2. Carboline Company, Inc.

3. Ceilcote USA, Inc.

4. Devoe Coating Company, Division of ICI.

5. ITW Devcon Futura Coatings, Inc.

6. International Protective Coatings.

7. Keeler & Long, Inc., Division of PPG Industries, Inc.

8. Pittsburgh Paints, PPG Industries Inc.

9. Sherwin-Williams.

10. Tnemec Company, Inc.

11. Equivalent coatings (on approval by Engineer/Architect) are acceptable from the following alternate companies:

    a. E.I. DuPont de Nemours & Co., Inc.
    b. Benjamin Moore Company.
    c. Coronado Paint Company.
    d. Rust-Oleum.

e. Sigma Coatings USA B.V.
f. U.S. Coatings, Inc.

2.2 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.

2.3 COATING SYSTEMS

A. Specified on the "Protective Coating System" sheets at the end of this Section.

2.4 SURFACES TO BE COATED

A. System A-1:

1. Hollow metal doors.
2. Hollow metal frames.
3. Interior structural steel.
4. Steel stair, handrail, & guardrail.

2.5 System A-6:

1. Metal roof deck.

2.6 System B-2:

1. Exterior galvanized structural steel.

2.7 System F-4:

1. Concrete masonry units.

2.8 System J-1:

1. Gypsum board.

2.9 SURFACES NOT TO BE COATED

A. Prefinished equipment.

B. Fire labels on doors and frames.

2.10 COLOR CODING OF PIPING AND PHYSICAL HAZARDS

A. Color Coding Physical Hazards: Exterior and interior.

1. General:
   a. Paint areas indicated to identify physical hazard areas as required by ANSI Z53.1.
   b. All colors shall conform to Federal Safety Color Code requirements.

2. Color Coding:

Area or Item	Color
Fire Protection Equipment and Apparatus, Danger or Stop	Red
Caution - Moving Hazards	Orange
Caution - Stationary Hazards	Yellow or Yellow and Black Stripes
Safety Areas and First Aid Equipment	Green
Housekeeping and Traffic Area Designations	White and Black Stripes

PART 3 - EXECUTION

3.1 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.
   a. Acid etching (ASTM D 4260) shall not be used for vertical surfaces.
   b. Acid etching shall only be used where:
      1) Procedures are in place for removal of acid residues and the handling, containment, and disposal of hazardous materials.
      2) 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.

3.2 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 (75mm) away from unprepared surface of any substrate such as areas to be welded or bolted.

F. Environmental Conditions:

1. Atmospheric temperature must be 50°F (10°C) 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 5°F (2.8°C) 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.

3.3 INSPECTION:

A. Contractor shall provide and use a wet film gauges to check each application approximately every 15 minutes 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^{o}F (2.8^{o}C) or more above the dew point.

3.4 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 9000

SECTION 22 0100 – BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification Sections, apply to this and the other sections of Division 22.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for plumbing installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:

1. Submittals.
2. Material and Equipment Selection.
3. Coordination drawings.
4. Record documents.
5. Maintenance manuals.

1.3 REFERENCED STANDARDS

A. International Plumbing Code 2012 (IPC)

B. International Fuel Gas Code 2012 (IFGC)

C. ASHRAE Standard 90.1, Energy Efficiency Design of New Buildings Except Low-Rise Residential Buildings.

1.4 CONTRACTOR'S SUBMITTAL REVIEW RESPONSIBILITIES

A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.

1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.
2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

B. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.

1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.
2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.
3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.
4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.
5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.
6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

C. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
2. Submittals for the Operation and Maintenance Manual must be original documentation.
3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.

D. Refer to Division 01 and each individual Division 22 Section for additional submittal requirements.

E. Prepare maintenance manuals in accordance with Division 01. In addition to 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 and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.
5. Facsimiles or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock.

F. Prepare and submit Coordination Drawings as further described herein. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

G. Coordination shall be drawn to a scale of ¼" = 1'0" or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to Plumbing piping, HVAC piping, and fire protection piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.
2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
3. Clearances for installing and maintaining insulation.
4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
5. Equipment and accessory service connections and support details.
6. Exterior wall and foundation penetrations.
7. Fire-rated wall and floor penetrations.
8. Sizes and location of required concrete pads and bases.
9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.
11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.
12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.

Floor plans and sections of fan rooms and mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

H. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e.,

traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of all underground piping.

2. Valve location diagrams, complete with valve tag chart. Refer to Division 220500 Section "Basic Plumbing Materials and Methods."
3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
5. Contract Modifications, actual equipment and materials installed.
6. Invert elevation of underfloor sanitary and storm piping.

I. Comply with each individual Division 22 Section for additional submittal requirements.

J. Electronic Media and Files:
1. Electronic media files of the contract drawings in AutoCAD or PDF format and copies of the specifications in PDF format may be requested.
2. Complete and return a signed "Electronic File Transmittal" form provided by Ross & Baruzzini upon request for electronic media,
3. Obtain approval from the appropriate Design Professional for use of their part of the documents if the information requested includes information prepared by other than Ross & Baruzzini.
4. The electronic contract documents may be used for preparation of shop drawings and record drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by Ross & Baruzzini for bidding purposes may not be used directly for raceway layout drawings or coordination drawings.
6. The use of these documents does not allow relief from the responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project with no guarantee by Ross & Baruzzini as to the accuracy or correctness of the information provided. Ross & Baruzzini accepts no responsibility or liability for the use of the provided information.

1.5 MATERIAL AND EQUIPMENT SELECTION

A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one "basis of design" manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the "basis of design" manufacturer are listed in the specifications, it shall be understood that the words "or approved equal by" are implied to precede each of the other manufacturer's names.

1. The manufacturers other than the "basis of design" may be furnished at the contractor's option in lieu of the "basis of design" product, provided that the selected manufacturer's product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.

2. Where a product is not scheduled on the drawings and, therefore, where no "basis of design" is indicated, selection among all of the listed manufacturers and products is at the contractor's option, subject to the requirements of the Contract Documents.
3. Products of manufacturers not listed in the Contract Documents are considered Substitutions and are not permitted, except as provided under the General and Supplementary Conditions and Division 01 Specifications. Full compliance with Division 01 section "Product Substitutions" is mandatory for acceptance of products or manufacturers not listed.

B. Listing of a manufacturer does not imply approval of that manufacturer's standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer's name and reputation. Final approval is subject to full compliance with these Contract Documents.

C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer's standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer's options, and/or accessories may be required to meet the specified requirements.

D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the "basis of design" manufacturer, type and model indicated. In the event that equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the "basis of design" are selected by the contractor and approved by the Owner's representative, any necessary adjustments are the contractor's responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor's selection of manufacturer, type, or model other than the "basis of design" require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner's added professional fee expenses.

E. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 22 section, do not assume that the selection of materials is the contractor's option. Refer to "Part 3 – Execution" subsection of that same Division 22 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

PRODUCTS (NOT APPLICABLE)

PART 2 - EXECUTION

2.1 GENERAL INSTALLATION

A. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

END OF SECTION 22 0100

SECTION 22 0500 – BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection” and Section 220100 “Basic Plumbing Requirements” apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes the following basic plumbing materials and methods to complement other Division 22 Sections:

1. Materials and installation instructions common to plumbing systems.
2. Pipe joining materials and methods.
3. Dielectric fittings.
4. Plumbing sleeve seals.
5. Pipe sleeves.
6. Escutcheons.
7. Penetration firestopping of fire-resistance-rated assemblies and/or smoke barriers by plumbing piping or conduit.
8. Labeling and identifying plumbing systems and equipment.
9. Coordination with Structural work.
10. Selective Demolition.
11. Cutting and patching.

B. Pipe and pipe fitting materials are specified in individual Division 22 piping system Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

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

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

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

F. The following abbreviations are used throughout Division 22 Specification Sections:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. CR: Chlorosulfonated polyethylene synthetic rubber.
4. EPDM: Ethylene propylene diene terpolymer rubber.
5. NBR: Acrylonitrile-butadiene rubber.
6. NP: Nylon plastic.
7. PE: Polyethylene plastic.
8. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For dielectric fittings, transition couplings, plumbing sleeve seals, and identification materials and devices.

B. Shop Drawings: Detail fabrication and installation for supports and anchorage for plumbing materials and equipment.

C. Coordination Drawings: For access panel and door locations.

1.5 QUALITY ASSURANCE

A. Welding: Qualify welding processes and operators for structural steel according to AWS D1.1 “Structural Welding Code – Steel.”

B. Welding: Qualify welding processes and operators for piping according to ASME “Boiler and Pressure Vessel Code,” Section IX, “Welding and Brazing Qualifications.”

1. Comply with provisions of ASME B31 Series “Code for Pressure Piping.”
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.
3. Contactor shall retain all welding certificates on file and produce them for review upon request by the Owner and/or Owner’s representative.

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor or roof, if stored thereupon.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

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

E. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate plumbing equipment installation with other building components.

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

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

D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if plumbing items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Panels."

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

H. Coordinate connection of electrical services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

a. Dresser Industries, Inc.
b. or approved equal.

2. Dielectric Fittings:

a. Eclipse, Inc.; Rockford-Eclipse Div.
b. Grinnell Corp.; Grinnell Supply Sales Co.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Industries, Inc.; Wilkins Div.

3. Plumbing Sleeve Seals:

a. Advanced Products and Systems, Inc./Innerlynx
b. The Metraflex Company
c. Thunderline/Link-Seal.

4. Identifying Devices and Labels:

   a. Brady USA, Inc., Signmark Div.
   b. Brimar Industries, Inc.
   c. Kolbi Industries, Inc.
   d. Panduit Corp.
   e. Seton Name Plate Co.

2.2 PIPE AND PIPE FITTINGS

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

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for joining materials.

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

C. Solder Filler Metals: ASTM B32 lead-free alloys. Include water-flushable flux according to ASTM B813.

D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous, threaded, solder, plain, and weld-neck end types and matching piping system materials.

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

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180ºF (82 C).

2.5 MODULAR SLEEVE SEALS

A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Stainless steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

E. Minimum Temperature Rating: -40°F to +210°F (-40°C to +99°C).

2.6 PIPE SLEEVES

A. The following sleeve materials are for wall, floor, slab, and roof penetrations.

B. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

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

1. Underdeck Clamp: Clamping ring with setscrews.

E. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

F. Contractor’s Option: Pre-engineered, UL-listed fire-resistance rated and watertight cast-in-place floor sleeving systems meeting the following specifications will be acceptable in lieu of traditional floor sleeves with field-installed firestop, at contractor’s option.

1. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood and/or steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.
2. Manufacturer: Subject to compliance with requirements, provide Hydroflame™ sleeving system by Hubbard Enterprises / Holdrite; or approved equal.
3. Include an outer sleeve lined with an intumescent strip; and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork; or wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.
4. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab. For applications involving a corrugated deck, also include a cone attached to the base for extending the device through the metal deck.
5. Product shall provide a two-hour fire-resistance rated assembly when tested according to ASTM E814 or ANSI/UL 1479.

2.7 ESCUTCHEONS

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

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

C. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

D. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.

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

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

2.8 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22 Sections. If more than one type is specified for application, selection is installer's option, but provide one selection for each product category.

B. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

C. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment; furnished and factory-installed by original equipment manufacturer.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
2. Location: Accessible and visible location.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.

1. Nomenclature: Domestic Cold Water, Domestic Hot Water, Domestic Hot Water Return, Natural Gas, etc. as required per service. Match name to the name given on Drawings (full names, not abbreviations).
2. Color: Per ASME A13.1 Standard per service, unless noted otherwise.
3. Flow Direction: Indicate flow direction via arrows on each label.

E. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated.

1. Fabricate in sizes required for message.
2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
3. Punch for mechanical fastening.
4. Thickness: 1/16-inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) long; 1/8-inch (3.2 mm) for larger units.
5. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

F. Valve Tags: Photo-anodized barcode tags with ¼-inch (6-mm) letters and numbers. Include 5/32-inch (4-mm) hole for fastener.

1. Material: 0.032-inch (0.8-mm) thick anodized aluminum.
2. Color: Silver background with black characters.

3. Printed Nomenclature: Piping system abbreviation and sequenced number; e.g., HW-23 for domestic hot water supply valve #23; HWR-12 for domestic hot water return valve #12.
4. Barcode: Two-dimensional Data Matrix ECC 200 barcode symbology. Prior to manufacture, obtain valve tag information from owner's property manager for encoding into the barcode. Include valve number, piping system, system abbreviation, location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

G. Valve Tag Fasteners: Brass, wire-link chain or stainless steel beaded chain.

H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in plumbing identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: If multiple systems of same generic name are indicated, provide identification that indicates individual system number and service such as "Domestic Water Heater DWH1," "Hot Water Recirculation Pump HWRP1," or "Standpipe F12."

2.9 CONCRETE AND GROUT

A. Concrete: For all minor concrete work required for plumbing installations, such as concrete equipment bases and supports, refer to Division 03 Sections for specification of cast-in-place concrete and reinforcing materials, whose requirements apply to the work of Division 22 as if fully reproduced herein.

B. Non-shrink, Nonmetallic Grout: ASTM C1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 GENERAL PLUMBING INSTALLATION REQUIREMENTS

A. Verify all dimensions by field measurements.

B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

C. 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. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

E. Install plumbing 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. Extend grease fittings to an accessible location.

F. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.2 PIPE-PENETRATION INSTALLATION REQUIREMENTS

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

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
3. Insulated Piping: One-piece, stamped-steel type with spring clips.
4. Uninsulated Piping in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
5. Uninsulated Piping in Unfinished Spaces: One-piece, cast-brass type.
6. Uninsulated Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

B. Install escutcheons for existing piping penetrations of new walls, ceilings, and floors. Match type, material, and finish as specified for new piping, except that split-casting or split-plate type will be accepted in lieu of one-piece.

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

D. Cut sleeves to length for mounting flush with both surfaces. Exception: Extend sleeves installed in floors of mechanical/plumbing equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete, and finish even with top of sleeve. Install in complete and strict accordance with manufacturer’s UL-listed installation instructions.

F. Build sleeves into new walls and slabs as work progresses.

G. Install sleeves large enough to provide ¼-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS (DN150).
2. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section “Flashing and Sheet Metal” for flashing.

3. Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.

H. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 07 Section "Joint Sealants" for materials. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

I. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) in diameter and larger.
3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

J. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

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

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

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

3.3 EQUIPMENT INSTALLATION REQUIREMENTS

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Division 22 and Division 26 for rough-in requirements.

C. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

D. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

F. Positive attachment and anchorage of all equipment to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.

G. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

H. Install equipment giving right of way to piping installed at required slope.

I. Install flexible pipe connectors at the following locations. Install on equipment side of shutoff valves.

1. Inlet and outlet of each pump.
2. Where indicated elsewhere in these specifications.
3. Where detailed on the Drawings.

J. Support for Suspended Equipment: As specified in Division 22 Section “Hangers and Supports.”

3.4 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow. Use plastic markers, with application systems. Install on insulation segment if required for hot, uninsulated piping.

B. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior non-concealed locations:

1. Near each valve and control device.
2. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.
3. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible 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 of 50-foot (15-m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. Install continuous plastic underground warning tapes during back filling of trenches for underground piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 31 Section “Earth Moving” for warning-tape materials and devices and their installation.

D. Equipment: Install engraved plastic-laminate sign on or near each major item of plumbing equipment.

1. Lettering Size: Minimum ¼-inch- (6.4-mm-) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), ½-inch- (12.7-mm-) high lettering for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.

2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

E. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

F. Install valve tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, and similar roughing-in connections of end-use fixtures and units.

3.5 COORDINATION WITH STRUCTURAL WORK

A. Concrete: Do not embed pipes, wires, tube, boxes, ducts or other cavity-creating elements in concrete work unless shown on or permitted by the structural drawings. Openings through concrete not shown on the structural drawings are subject to approval by the structural engineer of record. See coordination drawing requirements under Submittals.

B. Roof Deck: Do not place loads on, or hang any loads whatsoever from roof deck, unless shown on structural drawings, including, but not limited to, hangers for pipes, ducts, equipment, etc. Trade contractor installing such loads shall provide sub-framing connected to steel frame.

1. Do not exceed capacity of roof deck as a working platform. Submit all proposed construction loads to deck supplier for approval.
2. Openings in roof deck not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be cut and reinforced by trade requiring opening.

C. Supported Slab: Do not suspend loads exceeding 500 pounds within any 100 square feet of contiguous area from concrete supported slab. Suspend such loads from structural steel only. Any “sub-framing” required is responsibility of Contractor or sub-contractor installing material requiring support.

1. Openings in concrete floor slabs not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be the responsibility of the trade requiring openings. Form block-outs in the slab, reinforcing deck, and cut openings after concrete has reached specified strength.
2. Where openings larger than 12-inches are required but not shown on structural drawings, secure written approval from Architect/Engineer prior to cutting deck.

3.6 ERECTION OF SUPPORTS AND ANCHORAGE

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

B. Field Welding: Comply with AWS D1.1, “Structural Welding Code – Steel.”

3.7 SELECTIVE DEMOLITION

A. Disconnect, demolish, and remove plumbing work as indicated on the Drawings, and as required for installation of new work shown. Coordinate with Division 26 for disconnection of power to electrically-powered equipment prior to demolition.

B. Remove accessible work in its entirety. Repair cut surfaces to match adjacent surfaces. Abandon in place embedded or buried work, unless noted otherwise.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

C. Removal: Unless otherwise indicated, remove demolished pipe, and equipment from the Project site. Handle and dispose of in accordance with National, State, and Local regulations.

1. Relocation: Remove, store, clean, reinstall, reconnect, and make operational all work indicated for relocation.
2. Salvage: Remove and deliver to Owner all work indicated for salvage.

D. Refer to Division 01 Sections “Selective Demolition” and/or “Selective Structure Demolition” for additional requirements.

E. For selective demolition of any appliance or piece of equipment containing a CFC, HCFC, or HFC refrigerant: Prior to demolition, refrigerant shall be evacuated and captured in full compliance with the Clean Air Act; using only technicians with the proper refrigerant license as according to law, stored in approved containers, and shipped to a licensed refrigerant recycling facility all as required by the United States Environmental Protection Agency.

3.8 CUTTING AND PATCHING

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay. Perform cutting and patching in accordance with the following:

B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

C. Perform cutting, fitting, and patching of plumbing equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.
2. Remove and replace defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Install equipment and materials in existing structures.

D. Cut, remove and legally dispose of selected plumbing equipment, components, and materials as indicated, including but not limited to removal of plumbing piping, pumps, and other plumbing items made obsolete by the new Work.

E. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for plumbing installations. Perform cutting by skilled mechanics of trades involved.

F. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

H. Repair cut surfaces to match adjacent installations.

I. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to make a plumbing installation, so as to maintain an equivalent insulation or fire rating as existed without said plumbing installation.

J. Refer to Division 01 Sections “Execution” and/or “Cutting and Patching” for additional requirements.

3.9 GROUTING

A. Install nonmetallic, non-shrink, grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Mix grout according to manufacturer’s written instructions. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Place grout, completely filling equipment bases. Avoid air entrapment during placing of grout. Place grout on concrete bases to provide smooth bearing surface for equipment. Place grout around anchors.

E. Cure placed grout according to manufacturer’s written instructions.

END OF SECTION 22 0500

SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection,” Section 220100 “Basic Plumbing Requirements,” and Section 220500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two weeks in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

1. Soil, Waste, and Vent Piping: 10-foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

A. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) ® and listed by NSF International.

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

C. Pipe and Fittings shall be “Made In The U.S.A”.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Tensile Strength: 21,000 psig minimum.

D. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF International.

E. Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer’s registered trademark by which the manufacturer can be readily identified after installation.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 and CISPI 301.

B. Tensile Strength: 21,000 psig minimum.

C. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF International.

D. Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer’s registered trademark by which the manufacturer can be readily identified after installation.

E. CISPI Heavy-Duty, Hubless-Piping Couplings:

1. Standards: ASTM C 1540 and CISPI 310.
2. Description: Shield Assemblies shall consist of stainless-steel bi-directional corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop. Couplings shall bear the trademark NSF International.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 200800 “Seismic Protection”. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

    a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
    b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

    a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

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

3.4 VALVE INSTALLATION

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 200800 “Seismic Protection”.

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
5. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220500 "Basic Plumbing Materials and Methods"

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

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

6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 6 and smaller shall be the following:
1. Hubless, cast-iron soil pipe and fittings and hubless, CISPI heavy-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, vent piping NPS 4 and smaller shall be the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Underground, soil, waste, and vent piping NPS 6 and smaller shall be the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 22 1316

SECTION 22 1319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 20 0800 “Seismic Protection,” Section 22 0100 “Basic Plumbing Requirements,” and Section 22 0500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Miscellaneous sanitary drainage piping specialties.
3. Floor sinks.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

1.4 ACTION SUBMITTALS

A. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Approved manufacturers are J. R. Smith, Josam, and Zurn.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Approved manufacturers are J. R. Smith, Josam, and Zurn.
2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron.
5. Closure: Brass plug with tapered threads.
6. Adjustable Housing Material: Cast iron with threads.
7. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
8. Frame and Cover Shape: Round.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

2.4 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.5 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Approved manufacturers are Josam, J. R. Smith and Zurn.
2. See schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

D. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

E. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

F. Install fire-rated wood-blocking reinforcement for wall-mounting-type specialties.

G. Install traps on plumbing specialty drain outlets.

H. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

   a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

D. Set flashing on floors and roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign:

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1319

SECTION 23 0100 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:

1. Submittals.
2. Material and Equipment Selection.
3. Coordination drawings.
4. Record documents.
5. Maintenance manuals.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 23.

1.3 CONTRACTOR'S SUBMITTAL RESPONSIBILITIES

A. General: Follow the procedures specified in Division 01. In addition to the requirements specified in Division 01, comply with the following:

1. Increase by two (2) the quantity of print copies required by Division 01 for submittals, if paper submittals are used. (Paperless electronic submittals are preferred.)
2. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number. Transmit via email. Include PDF transmittal form. Include information in email subject line as to project name, project number, submittal number, and applicable specification section number.
3. Submit line-by-line specification verification for equipment other than the "basis of design" as further described in the following article "Material and Equipment Selection".

B. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.

1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.
2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this

substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

C. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.

1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.
2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.
3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.
4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.
5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.
6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

D. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
2. Submittals for the Operation and Maintenance Manual must be original documentation.
3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.

E. Coordination Drawings: Prepare and submit Coordination Drawings as further described herein and as indicated in the Special Conditions. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

F. Refer to Division 01 and each individual Division 23 Section for additional submittal requirements.

1.4 REFERENCED STANDARDS

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers. Guideline 4-2008 (RA 2013) *Preparation of Operating and Maintenance Documentation for Building Systems*. Atlanta, GA: ASHRAE, 1993.

1.5 MATERIAL AND EQUIPMENT SELECTION

A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one "basis of design" manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the "basis of design" manufacturer are listed in the specifications, it shall be understood that the words "or approved equal by" are implied to precede each of the other manufacturer's names.

1. The manufacturers other than the "basis of design" may be furnished at the contractor's option in lieu of the "basis of design" product, provided that the selected manufacturer's product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.
2. Where a product is not scheduled on the drawings and, therefore, where no "basis of design" is indicated, selection among all of the listed manufacturers and products is at the contractor's option, subject to the requirements of the Contract Documents.
3. Products of manufacturers not listed in the Contract Documents are considered Substitutions and are not permitted, except as provided under the General and Supplementary Conditions and Division 01 Specifications. Full compliance with Division 01 section "Product Substitutions" is mandatory for acceptance of products or manufacturers not listed.

B. Listing of a manufacturer does not imply approval of that manufacturer's standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer's name and reputation. Final approval is subject to full compliance with these Contract Documents.

C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer's standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer's options, and/or accessories may be required to meet the specified requirements.

D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the "basis of design" manufacturer, type and model indicated. In the event that equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the "basis of design" are selected by the contractor and approved by the Owner's representative, any necessary adjustments are the contractor's responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment

provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor's selection of manufacturer, type, or model other than the "basis of design" require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner's added professional fee expenses.

E. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 23 section, do not assume that the selection of materials is the contractor's option. Refer to "Part 3 – Execution" subsection of that same Division 23 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

1.6 COORDINATION DRAWINGS

A. Prepare project coordination drawings to a scale of ¼" = 1'0" or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to HVAC piping, plumbing piping, and fire protection piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.
2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
3. Clearances for installing and maintaining insulation.
4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
5. Equipment and accessory service connections and support details.
6. Exterior wall and foundation penetrations.
7. Fire-rated wall and floor penetrations.
8. Sizes and location of required concrete pads and bases.
9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.
11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.
12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.
13. Floor plans and sections of fan rooms and mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

1.7 ELECTRONIC MEDIA AND FILES

A. Electronic media files of the contract drawings in AutoCAD or PDF format and copies of the specifications in PDF format may be requested.

B. Complete and return a signed "Electronic File Transmittal" form provided by Ross & Baruzzini upon request for electronic media.

C. Obtain approval from the appropriate Design Professional for use of their part of the documents if the information requested includes information prepared by other than Ross & Baruzzini.

D. The electronic contract documents may be used for preparation of shop drawings and record drawings only. The information may not be used in whole or in part for any other project.

E. The drawings prepared by Ross & Baruzzini for bidding purposes may not be used directly for raceway layout drawings or coordination drawings.

F. The use of these documents does not allow relief from the responsibility for coordination of work with other trades and verification of space available for the installation.

G. The information is provided to expedite the project with no guarantee by Ross & Baruzzini as to the accuracy or correctness of the information provided. Ross & Baruzzini accepts no responsibility or liability for the use of the provided information.

1.8 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:

1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of all underground piping.
3. Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Basic Mechanical Materials and Methods."
4. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
5. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
6. Contract Modifications, actual equipment and materials installed.

1.9 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01. In addition to 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 and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Facsimiles or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock.

B. In addition to the above, comply with ASHRAE Guideline 4-2008 (RA 2013) *Preparation of Operating and Maintenance Documentation for Building Systems*.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. During construction, meet or exceed the recommended Design Approaches of SMACNA *IAQ Guideline for Occupied Buildings under Construction*.

B. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

END OF SECTION 23 0100

SECTION 23 0500 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections:

1. Materials and installation instructions common to mechanical systems.
2. Pipe joining materials and methods.
3. Flexible pipe connectors.
4. Labeling and identifying mechanical systems and equipment.
5. Non-shrink grout for equipment installations.
6. Painting and finishing of mechanical work.
7. Concrete base construction requirements.
8. Coordination with Structural work.
9. Field-fabricated equipment supports.
10. Selective Demolition.
11. Cutting and patching.

1.2 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. Section 23 0100 “Basic Mechanical Requirements” applies to the work of this Section as if fully repeated herein.

C. Pipe and pipe fitting materials are specified in individual Division 23 piping system Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

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

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

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

F. The following abbreviations are used throughout Division 23 Specification Sections:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. CR: Chlorosulfonated polyethylene synthetic rubber.
4. EPDM: Ethylene propylene diene terpolymer rubber.
5. NBR: Acrylonitrile-butadiene rubber.
6. NP: Nylon plastic.
7. PE: Polyethylene plastic.
8. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For transition couplings, flexible pipe connectors and identification materials and devices.

B. Shop Drawings: Detail fabrication and installation for supports and anchorage for mechanical materials and equipment.

1.5 QUALITY ASSURANCE

A. Welding: Qualify welding processes and operators for structural steel according to AWS D1.1 “Structural Welding Code – Steel.”

B. Welding: Qualify welding processes and operators for piping according to ASME “Boiler and Pressure Vessel Code,” Section IX, “Welding and Brazing Qualifications.”

1. Comply with provisions of ASME B31 Series “Code for Pressure Piping.”
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.
3. Contactor shall retain all welding certificates on file and produce them for review upon request by the Owner and/or Owner’s representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor or roof, if stored thereupon. Protect flanges, fittings, and piping specialties from moisture and dirt.

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

C. Protect ductwork interiors from the elements and foreign materials throughout construction. Deliver ducts with shop-applied impervious protective covering over all open ends. Maintain protective end coverings through shipping, storage, and handling to prevent entrance of dirt, debris, and moisture. Elevate stored ducts above grade. As ductwork is installed, remove protective end covering as each successive segment is connected, but with protective end covering maintained over open ends remaining exposed.

D. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

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

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

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Coordinate connection of electrical services.

H. Dielectric fittings are not allowed. Install bronze shutoff valve where dissimilar metals are joined. Valve must be installed in an accessible area or above an access panel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Transition Couplings:

a. Dresser Industries, Inc.
b. or approved equal.

2. Flexible Pipe Connectors:

a. Flexicraft Industries, Inc.
b. Hyspan Precision Products, Inc.
c. Mason Industries, Inc.
d. The Metraflex Company
e. Proco Products, Inc.

3. Identifying Devices and Labels:

    a. Brady USA, Inc., Signmark Div.
    b. Brimar Industries, Inc.
    c. Kolbi Industries, Inc.
    d. Panduit Corp.
    e. Seton Name Plate Co.

2.2 PIPE AND PIPE FITTINGS

A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

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

C. Pipe-Flange Joining Gaskets: ASME B16.21, EPDM, flat, asbestos-free, 1/8-inch (3.2-mm) thickness, unless noted otherwise.

1. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
2. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

D. Pipe-Flange Joining Bolts and Nuts: ASME B18.2.1 bolts with ASME B18.2.2 nuts, carbon steel, unless otherwise indicated.

1. Bolts and nuts shall be Type 304 or Type 316 stainless steel, if installed on stainless steel piping, and matching the grade of stainless steel piping.
2. Bolts and nuts shall be Type 304 stainless steel if installed on uninsulated piping located outdoors.
3. Bolts and nuts shall be Type 316 stainless steel if installed on uninsulated direct-bury piping.

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

1. Bolts and nuts shall be Type 304 stainless steel if installed on uninsulated piping located outdoors.
2. Bolts and nuts shall be Type 316 stainless steel if installed on uninsulated direct-bury piping.

F. Solder Filler Metals: ASTM B32 lead-free alloys. Include water-flushable flux according to ASTM B813.

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

H. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

I. Solvent Cements: Manufacturer's standard solvent cements for the following:

1. ABS Piping: ASTM D2235.
2. CPVC Piping: ASTM F493.
3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
4. PVC to ABS Piping Transition: ASTM D3138.

J. Plastic Pipe Seals: ASTM F477, elastomeric gasket.

K. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts unless noted otherwise.

1. Bolts and nuts shall be Type 304 stainless steel if installed on uninsulated piping located outdoors.
2. Bolts and nuts shall be Type 316 stainless steel if installed on uninsulated direct-bury piping.

L. Transition Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.

1. Sleeve: ASTM A126, Class B, gray iron.
2. Followers: ASTM A47 (ASTM A47M) malleable iron or ASTM A536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.4 FLEXIBLE PIPE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide equipment-pipe connections.

B. Flexible Pipe Connectors for Copper Piping: Corrugated bronze inner tubing covered with interwoven bronze wire braid. Include copper-tube ends, brazed to hose.

C. Flexible Pipe Connectors for Steel Piping: Corrugated stainless-steel inner tubing covered with interwoven stainless-steel wire braid.

D. Performance Rating Requirements:

1. Misalignment: Rated for ¾-inch (20-mm) permanent lateral offset.
2. Length: As needed to allow offset rating above, but not less than 9-inches (230 mm).
3. Design Working Pressure: 150 psig (1035 kPa) at 300°F (149°C).

E. Schedule of End Connections:

1. 2-Inch NPS (DN50) and Smaller, Copper Pipe: Copper tube end connections suitable for soldering to adjacent piping; except that brazed end connections are required for refrigerant service.
2. 2-Inch NPS (DN50) and Smaller, Steel Pipe: Threaded-end carbon steel nipples welded to hose; except that stainless-steel ends are required for natural gas service or where mated to stainless steel piping.
3. 2½-Inch NPS (DN65) and Larger: Carbon-steel flanged end connections welded to hose and drilled to meet ANSI Class 150; except that stainless-steel flanged end connections are required for natural gas service or where mated to stainless steel piping.

F. Flexible pipe connectors specified herein are for use at the piping connection to a piece of mechanical equipment, including but not limited to pumps. These are not acceptable for use where “expansion joints” or “pipe expansion fittings” are called out. Refer to Division 23 Section “Pipe Expansion Fittings” for pipe expansion joints or pipe expansion fittings.

2.5 PIPE SLEEVES

A. The following sleeve materials are for wall, floor, slab, and roof penetrations.

B. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

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

1. Underdeck Clamp: Clamping ring with setscrews.

E. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

F. Contractor’s Option: Pre-engineered, UL-listed fire-resistance rated and watertight cast-in-place floor sleeving systems meeting the following specifications will be acceptable in lieu of traditional floor sleeves with field-installed firestop, at contractor’s option.

1. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood and/or steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.
2. Manufacturer: Subject to compliance with requirements, provide Hydroflame™ sleeving system by Hubbard Enterprises / Holdrite; or approved equal.
3. Include an outer sleeve lined with an intumescent strip; and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork; or wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.
4. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab. For applications involving a corrugated deck, also include a cone attached to the base for extending the device through the metal deck.

5. Product shall provide a two-hour fire-resistance rated assembly when tested according to ASTM E814 or ANSI/UL 1479.

2.6 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23 Sections. If more than one type is specified for application, selection is installer's option, but provide one selection for each product category.

B. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

C. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment; furnished and factory-installed by original equipment manufacturer.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
2. Location: Accessible and visible location.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.

1. <u>All pipe coverings shall match similar to existing pipe covers installed at East Campus Chiller Plant. Refer to Division 23 Section Mechanical Insulation 230700.</u>

2. Nomenclature: Heating Water Supply, Heating Water Return, Chilled Water Supply, Chilled Water Return, Natural Gas, etc. as required per service. Match name to the name given on Drawings (full names, not abbreviations).
3. Color: Per ASME A13.1 Standard per service, unless noted otherwise.
4. Flow Direction: Indicate flow direction via arrows on each label.

E. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, white surface, black lettering, with white melamine subcore, unless otherwise indicated.

1. Fabricate in sizes required for message.
2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
3. Punch for mechanical fastening.
4. Thickness: 1/16-inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) long; 1/8-inch (3.2 mm) for larger units.
5. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

F. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: If multiple systems of same generic name are indicated, provide identification that indicates individual system number and service such as “Boiler No. 3,” “Air Supply No. 1H,” or “Standpipe F12.”

G. Chiller Room Warning Sign: Each entrance to a refrigerating machinery room shall be provided with a legible permanent sign, securely attached and easily accessible, reading “Machinery Room – Authorized Personnel Only.” A second sign shall further state “Audible and Visual Refrigerant Alarm Sounding Indicates Refrigerant Detection – Entry is Forbidden Except by Those Personnel Trained in Emergency Procedures.”

2.7 CONCRETE AND GROUT

A. Concrete: For all minor concrete work required for mechanical installations, such as concrete equipment bases and supports, provide Quikrete® Commercial Grade FastSet™ Concrete #1004-51 prepackaged concrete mix, or approved equal. Mix, place, and cure in accordance with manufacturer’s written instructions.

B. Concrete Reinforcing: ASTM A615 Grade 60 deformed bars and ASTM A185 welded wire fabric.

C. Non-shrink, Nonmetallic Grout: ASTM C1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.8 PAINTING AND FINISHING

A. Master Painters Institute, Inc. (MPI) Standards: Provide paint and paint products that comply with MPI standards indicated and that are listed in its “MPI Approved Products List.”

B. Material Compatibility: Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

C. Colors: As directed by Owner’s representative. Each pipe shall be painted a designated color according to service.

D. Furnish 5 percent extra paint, but not less than 1 gallon of each material and color applied, from the same product run, that match products installed and that are packaged for storage and identified with labels describing contents.

E. Mechanical Room Floor Paint: Sherwin Williams ArmorSeal 8100 (D70W8161) water-based epoxy in Satin finish and Shark Grip additive for slip resistance.

PART 3 - EXECUTION

3.1 GENERAL MECHANICAL INSTALLATION REQUIREMENTS

A. Verify all dimensions by field measurements.

B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

C. 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. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

E. Install mechanical 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. Extend grease fittings to an accessible location.

F. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.2 PIPING SYSTEM INSTALLATION REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.

B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

C. Install components with pressure rating equal to or greater than system operating pressure.

D. Install piping at indicated slope, and free of sags and bends.

E. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal. Install piping to allow application of insulation plus 1-inch (25-mm) clearance around insulation.

F. Locate groups of pipes parallel to each other, arranged and spaced to permit valve servicing.

G. Install fittings for changes in direction and branch connections. Install couplings according to manufacturer’s written instructions.

H. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

I. Electrical Equipment Spaces: Route piping to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

J. Piping Support: As specified in Division 23 Section “Hangers and Supports.”

3.3 PIPING JOINING REQUIREMENTS

A. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections.

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.

E. Brazed Joints: Construct joints according to AWS’s “Brazing Handbook,” “Pipe and Tube” Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

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 pipefittings and valves as follows:

1. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
3. Align threads at point of assembly.
4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, “Recommended Practices and Procedures for Welding Low Carbon Steel Pipe,” using qualified processes and welding operators according to “Quality Assurance” Article.

1. Apply one coat of self-priming, rust-inhibitor paint around the entire circumference of each welded pipe joint; regardless of whether or not the piping is specified to be painted. Paint may be brush-applied, roller-applied, or spray-applied at contractor’s option.

H. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as

possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: ASTM D2235 and ASTM D2661.
3. CPVC Piping: ASTM D2846 and ASTM F493.
4. PVC Pressure Piping: ASTM D2672.
5. PVC Non-pressure Piping: ASTM D2855.
6. PVC to ABS Non-pressure Transition Fittings: Procedure and solvent cement according to ASTM D3138.

J. Piping Connections: Make connections according to the following, unless otherwise indicated.

1. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.
2. Install flanges, in piping 2½-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
3. Install dielectric flanges to connect piping materials of dissimilar metals.
4. Valve Caps: Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

3.4 PIPE-PENETRATION INSTALLATION REQUIREMENTS

A. Except as noted otherwise, install escutcheons for both insulated and bare piping in the following cases:

1. New piping of penetrations of newly-constructed walls, ceilings, and floors.
2. New piping penetrations of existing walls, ceilings, and floors.
3. Existing piping which penetrates newly-constructed walls, ceilings, and floors.

B. Escutcheons are not required in the following cases. Note that some form of closure of the annular or overcut opening (for reasons of acoustics, fire/smoke, sight, etc.) may still be required by other provisions of these documents.

1. Existing piping which penetrates existing walls, ceilings, and floors.
2. Wall penetrations in an unfinished cavity above a finished ceiling.
3. Penetrations of a wall or partition dividing one unfinished space from another unfinished space, such as service spaces, storage rooms, and equipment rooms.

C. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening. Use one-piece type for new piping and split-plate type for existing piping as specified in Part 2 of this section.

D. Install floor plates for piping penetrations of unfinished floors in service spaces and equipment rooms. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening. Use one-piece floor-plate type for new piping and split-casting floor-plate type for existing piping as specified in Part 2 of this section.

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

F. Cut sleeves to length for mounting flush with both surfaces. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

G. Build sleeves into new walls and slabs as work progresses.

H. Install sleeves large enough to provide ¼-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS (DN150).
2. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section “Flashing and Sheet Metal” for flashing.
3. Seal space outside of sleeve fittings with non-shrink, non-metallic grout.

I. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 07 Section “Joint Sealants” for materials. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

J. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and modular sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing modular sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron “wall pipes” for sleeves 6 inches (150 mm) in diameter and larger.
3. Assemble and install modular sleeve seals according to manufacturer’s written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

K. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron “wall pipes” for sleeves. Seal pipe penetrations using modular sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing modular sleeve seals. Assemble and install modular sleeve seals according to manufacturer’s written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

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

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

3.5 EQUIPMENT INSTALLATION REQUIREMENTS

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to equipment specifications in Division 23 and Division 26 for rough-in requirements.

B. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

C. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

D. Positive attachment and anchorage of all equipment to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.

E. Install flexible pipe connectors at the following locations. Install on equipment side of shutoff valves.
1. Where indicated elsewhere in these specifications.
2. Where detailed on the Drawings.

F. Support for Suspended Equipment: As specified in Division 23 Section “Hangers and Supports.”

3.6 LABELING AND IDENTIFYING

A. <u>All pipe coverings shall match similar to existing pipe covers installed at East Campus Chiller Plant. Refer to Division 23 Section Mechanical Insulation 230700.</u>

B. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior non-concealed locations:

1. Near each valve and control device.
2. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.
3. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible 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 of 50-foot (15-m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. Install continuous plastic underground warning tapes during back filling of trenches for underground piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 31 Section “Earth Moving” for warning-tape materials and devices and their installation.

D. Equipment: Install engraved plastic-laminate sign on or near each major item of mechanical equipment.
   1. All new equipment labels shall match existing equipment at East Campus Chiller Plant. New Chiller, Tower Pump and Basket Strainer labels shall match existing equipment labels.

   2. Lettering Size: Minimum ¼-inch- (6.4-mm-) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), ½-inch- (12.7-mm-) high lettering for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
   3. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

E. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers showing duct system service and direction of flow. In each space, if ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet (15 m).

F. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

G. Install valve tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

3.7 PAINTING AND FINISHING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45ºF. Maintain containers in clean condition, free of foreign materials and residue. Remove rags and waste from storage areas daily.

B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50ºF and 95ºF. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5ºF above the dew point; or to damp or wet surfaces.

C. Examine substrates and conditions for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected. Application of coating indicates acceptance of surfaces and conditions.

F. Comply with manufacturer’s written instructions and recommendations in “MPI Manual” applicable to substrates indicated.

G. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints. Remove surface oxidation, loose mill scale, and shop primer, if any. Clean field welds, bolted connections, and abraded areas of shop paint.

H. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual." Use applicators and techniques suited for paint and substrate indicated. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

I. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

J. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

K. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

L. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

M. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

N. Painting HVAC Work: Paint the following work where exposed to view in finished or unfinished spaces: Uninsulated steel piping, pipe hangers and supports, tanks that do not have factory-applied final finishes, all interior and exterior ferrous piping and appurtenances, including steel, galvanized steel, cast iron and ductile iron.

O. In addition, paint the following:

1. Duct, equipment, and pipe insulation having ASJ or other paintable jacket material.
2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.
3. Mechanical room floors and all equipment curb edges.

P. Steel Substrates: Primer, alkyd, anti-corrosive, for metal, MPI #79; plus topcoat of latex, interior, semi-gloss, MPI #54.

Q. Galvanized-Metal Substrates: Primer, galvanized, water based, MPI #134; plus topcoat of latex, interior, semi-gloss, MPI #54.

R. Aluminum (Not Anodized or Otherwise Coated) Substrates: Primer, quick dry, for aluminum, MPI #95; plus topcoat of latex, interior, semi-gloss, MPI #54.

S. ASJ Insulation-Covering Substrates: Including pipe and duct coverings. Primer sealer, latex, interior, MPI #50; plus topcoat of latex, interior, semi-gloss, MPI #54.

T. Primers specified above may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

3.8 CONCRETE BASES

A. Anchor equipment to concrete base according to equipment manufacturer's written instructions.

B. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

C. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts according to anchor-bolt manufacturer's written instructions. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. When anchoring equipment that is installed on neoprene or rubber vibration isolator pads, the anchor bolt shall include a neoprene or rubber grommet placed between the nut and the equipment frame so as not to short-circuit the vibration isolation provided by the neoprene pad. An example of one such device is Model GW Grommet Washers by Vibro-Acoustics, a Swegon Group company.

H. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.9 COORDINATION WITH STRUCTURAL WORK

A. Concrete: Do not embed pipes, wires, tube, boxes, ducts or other cavity-creating elements in concrete work unless shown on or permitted by the structural drawings. Openings through concrete not shown on the structural drawings are subject to approval by the structural engineer of record. See coordination drawing requirements under Submittals.

B. Roof Deck: Do not place loads on, or hang any loads whatsoever from roof deck, unless shown on structural drawings, including, but not limited to, hangers for pipes, ducts, equipment, etc. Trade contractor installing such loads shall provide sub-framing connected to steel frame.

1. Do not exceed capacity of roof deck as a working platform. Submit all proposed construction loads to deck supplier for approval.
2. Openings in roof deck not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be cut and reinforced by trade requiring opening.

C. Supported Slab: Do not suspend loads exceeding 500 pounds within any 100 square feet of contiguous area from concrete supported slab. Suspend such loads from structural steel only.

Any "sub-framing" required is responsibility of Contractor or sub-contractor installing material requiring support.

1. Openings in concrete floor slabs not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be the responsibility of the trade requiring openings. Form blockouts in the slab, reinforcing deck, and cut openings after concrete has reached specified strength.
2. Where openings larger than 12-inches are required but not shown on structural drawings, secure written approval from Architect/Engineer prior to cutting deck.

3.10 ERECTION OF SUPPORTS AND ANCHORAGE

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

B. Field Welding: Comply with AWS D1.1, "Structural Welding Code – Steel."

3.11 SELECTIVE DEMOLITION

A. Disconnect, demolish, and remove mechanical work as indicated on the Drawings, and as required for installation of new work shown. Coordinate with Division 26 for disconnection of power to electrically-powered equipment prior to demolition.

B. Remove accessible work in its entirety. Repair cut surfaces to match adjacent surfaces. Abandon in place embedded or buried work, unless noted otherwise.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

C. Removal: Unless otherwise indicated, remove demolished pipe, duct and equipment from the Project site. Handle and dispose of in accordance with National, State, and Local regulations.

1. Relocation: Remove, store, clean, reinstall, reconnect, and make operational all work indicated for relocation.
2. Salvage: Remove and deliver to Owner all work indicated for salvage.

D. Refer to Division 01 Sections "Selective Demolition" and/or "Selective Structure Demolition" for additional requirements.

E. For selective demolition of any appliance or piece of equipment containing a CFC, HCFC, or HFC refrigerant: Prior to demolition, refrigerant shall be evacuated and captured in full compliance with the Clean Air Act; using only technicians with the proper refrigerant license as according to law, stored in approved containers, and shipped to a licensed refrigerant recycling facility all as required by the United States Environmental Protection Agency.

3.12 CUTTING AND PATCHING

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay. Perform cutting and patching in accordance with the following:

B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

C. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.
2. Remove and replace defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Install equipment and materials in existing structures.

D. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, pumps, and other mechanical items made obsolete by the new Work.

E. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

F. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

H. Repair cut surfaces to match adjacent installations.

I. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to make a mechanical installation, so as to maintain an equivalent insulation or fire rating as existed without said mechanical installation.

J. Refer to Division 01 Sections “Execution” and/or “Cutting and Patching” for additional requirements.

3.13 GROUTING

A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Mix grout according to manufacturer’s written instructions. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Place grout, completely filling equipment bases. Avoid air entrapment during placing of grout. Place grout on concrete bases to provide smooth bearing surface for equipment. Place grout around anchors.

E. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 23 0500

SECTION 23 0513 – MOTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes basic requirements for factory-installed motors associated with mechanical equipment specified elsewhere in Division 23.

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

1.2 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. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.

C. Related Sections include all other Division 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

B. ODP: Open drip-proof.

C. TEFC: Totally-enclosed, fan-cooled.

1.4 SUBMITTALS

A. Product Data: Submit motor product data with each associated equipment submittal. Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. UL Listing: Motors specified in this Section must be listed and labeled by Underwriters Laboratories and bear the UL logo.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:

1. Compatible with magnetic controllers, multi-speed controllers, and/or reduced-voltage controllers where applicable.
2. Designed and labeled for use with variable frequency controllers where applicable and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide motors by one of the following:

1. Baldor Electric Co.
2. General Electric Co.
3. Marathon Electric Mfg. Co.
4. Reliance Electric Co.
5. Siemens Energy & Automation, Inc.

2.2 BASIC MOTOR REQUIREMENTS

A. Basic requirements apply to all types of mechanical equipment motors, unless otherwise indicated.

1. Motors ½ HP and Larger: Polyphase.
2. Frequency Rating: 60 Hz.

B. Voltage Rating: NEMA standard voltage selected to operate on nominal voltage of circuit to which motor is connected.

C. Service Factor: According to NEMA MG 1, unless otherwise indicated, but at least 1.15 polyphase motors and 1.35 for single-phase motors.

D. Duty: Continuous duty at ambient temperature of 104°F (40°C) and at altitude of 3300 feet (1000 meters) above sea level.

E. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

F. Enclosure: All motors shall be TEFC, NEMA T frame, NEMA F1 assembly for horizontal applications and designed for the severe duty environment.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design E, medium induction motor, unless otherwise indicated.

1. Stator: Copper windings, unless otherwise indicated.
2. Rotor: Random-wound, squirrel cage, unless otherwise indicated.
3. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
4. Temperature Rise: Match insulation rating, unless otherwise indicated.
5. Insulation: Class F, unless otherwise indicated.

B. Code Letter Designation: Motors 15 HP and larger shall be NEMA starting Code F or Code G. Motors under 15 HP shall have manufacturer's standard starting characteristics.

C. Enclosure: Cast iron for motors 7½ HP and larger; rolled steel for motors smaller than 7½ HP; with enamel finish.

D. Efficiency: Motor efficiencies for motors one horsepower and greater shall in no case shall be less efficient than "Premium Efficiency" as defined in NEMA MG 1-2014 *Motors and Generators*. Motors shall be tested and labeled in accordance with NEMA MG 1-2014 Standard. Motor nameplate labeling shall include both the minimum and nominal efficiency.

E. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

F. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.
2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
3. Temperature Rise: Matched to rating for Class B insulation.
4. Insulation: Class H.
5. Motor shall be inverter-duty and shall not require the use of external cooling fans.

G. Shaft Grounding Ring: On any and all motors to be controlled by a Variable Frequency Motor Controller, include an engineered ring consisting of two or more rows of circumferential conductive microfibers to redirect shaft current and provide a low-impedance path from shaft to frame, bypassing the motor bearings. Factory-install on the motor shaft by sliding the ring over either end, and lock it in place with mechanically-fastened mounting brackets. Motors over 100 nameplate horsepower shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Product shall be "Aegis SGR" by Electro Static Technology (no substitutions).

H. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

I. Source Quality Control: Perform the following routine tests according to NEMA MG 1:

1. Measurement of winding resistance.
2. No-load readings of current and speed at rated voltage and frequency.
3. Locked rotor current at rated frequency.
4. High-potential test.
5. Alignment.

PART 3 - EXECUTION

3.1 INSTALLATION, ALL MOTORS

A. Use adjustable motor mounting bases for belt-driven motors. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions. Verify bearing lubrication.

B. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load. Test interlocks and control and safety features for proper operation. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.

C. Correct malfunctioning motors on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new motors and retest.

END OF SECTION 23 0513

SECTION 23 0519 – METERS AND GAGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manually-read and locally-read meters and gages listed below. Electronic meters that connect to a digital control system are specified in Division 23 Section "HVAC Instrumentation and Controls."
   1. Thermowells.
   2. Pressure gages.
   3. Test plugs.

1.2 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. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.

C. Meters, and gages furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 23 Sections.

D. This Section does not include meters and gages associated with a building energy management or control system; those devices are specified in Division 23 Section "Control Systems."

1.3 SUBMITTALS

A. Product Data: Submit product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

B. Product Certificates: For each type of meter and gage, from manufacturer.

C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of thermometers and gages.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Test Plugs:

a. Flow Design, Inc.
b. Miljoco Corporation.
c. Peterson Equipment Co., Inc. (“Pete’s Plugs”)
d. Sisco Manufacturing Company, Inc.
e. H.O. Trerice Co.
f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
g. Weiss Instruments, Inc.

2.2 THERMOWELLS

A. Thermowells: ASME B40.200; Pressure-tight, socket-type fitting with protective dry well made for insertion into piping threaded tee fitting.

1. Material for Use with Copper Tubing: Brass.
2. Material for Use with Steel Piping: Stainless steel.
3. Type: Stepped shank unless straight or tapered shank is indicated.
4. External Threads: NPS ½, NPS ¾, or NPS 1, (DN 15, DN 20, or DN 25) ASME B1.20.1 pipe threads.
5. Internal Threads: ½, ¾, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
6. Bore: Diameter required to match thermometer bulb or stem.
7. Insertion Length: Length required to match thermometer bulb or stem, to extend to center of pipe.
8. Lagging Extension: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
9. Bushings: For converting size of thermowell’s internal screw thread to size of thermometer connection.
10. Cap: Threaded, with chain permanently fastened to socket.
11. Heat-Transfer Medium: Oil, conductive jelly, or mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage with bottom connection; dry type, unless liquid-filled-case type is indicated.

1. Pressure gages serving pump differential measurement shall be liquid-filled.
2. Case: Drawn steel, brass, or aluminum with 4½-inch-diameter glass lens.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS ¼ (DN 8), ASME B1.20.1 pipe threads.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with enameled scale markings graduated in dual units of psi and kPa.

7. Pointer: Dark-colored metal.
8. Window: Glass, acrylic, or Lexan lens.
9. Ring: Brass or Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
11. Range (Fluids under Pressure): 0 to 160 psi.

B. Gage Attachments:

1. Snubbers: ASME B40.100, brass; with NPS ¼ (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device of material suitable for system fluid and working pressure. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of brass or stainless-steel pipe with NPS ¼ (DN 8) pipe threads.
3. Valves: Brass or stainless-steel needle-type, with NPS ¼ (DN 8), ASME B1.20.1 pipe threads. Ball valves are not acceptable.

2.4 TEST PLUGS

A. Description: Test-station fitting made for insertion into piping tee fitting.

1. Body: Brass or stainless steel with core inserts. Include extended stem on units to be installed in insulated piping, with length as required to extend beyond insulation
2. Test-Plug Cap: Gasketed and threaded cap, with retention chain.
3. Thread Size: NPS ½ (DN 15), ASME B1.20.1 pipe thread.
4. Minimum Pressure and Temperature Rating: 500 psig at 200ºF (3450 kPa at 93ºC).

B. Core Inserts: Two (2) EPDM self-sealing rubber valve types, suitable for inserting a 1/8-inch outside-diameter probe from a dial thermometer or pressure gage.

C. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

1. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125ºF (minus 4 to plus 52ºC).
2. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220ºF (minus 18 to plus 104ºC).
3. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
4. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells in vertical position in piping tees. Include bushings if required to match sizes. Install thermowells with extension on insulated piping. Fill thermowells with heat-transfer medium.

B. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

C. Install valve and snubber in piping for each pressure gage for fluids (except steam).

D. Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

E. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Multiple points at each pump as detailed on Drawings; Pressure gages serving pump differential measurement shall be liquid-filled and shall include snubber.
4. Where indicated on Drawings.

F. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

G. After installation, calibrate meters according to manufacturer's written instructions. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 23 0519

SECTION 23 0523 – VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves common to Division 23 mechanical piping systems:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Chainwheel actuators.

1.2 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. Section 23 0100 “Basic Mechanical Requirements,” and Section 23 0500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

C. The following Sections contain requirements that relate to this Section:
1. Division 23 Section “Basic Mechanical Materials and Methods” for valve tags and charts.
2. Division 23 Section “Control Systems” for control valves and actuators.
3. Division 23 piping Sections for specialty valves applicable to those Sections only.

D. Valves for fuel oil service, natural gas service, chemical treatment, refrigerant, medical gases, fire protection, and other specialty services are specified in their respective piping Section.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves used in this Section:

1. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. PTFE: Polytetrafluoroethylene plastic.
4. TFE: Tetrafluoroethylene plastic.
5. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.
6. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Maintenance Data: For each type of valve, to include in the operation and maintenance manual specified in Division 01. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

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

D. MSS Compliance: Comply with the various MSS Standard Practice documents referenced herein.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. 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

2.1 MANUFACTURERS

A. General: Subject to compliance with requirements, provide ball valves by one of the following:

1. Crane Co.; Crane Valve Group; Crane, Jenkins, & Stockham brands.
2. Milwaukee Valve Company.
3. NIBCO Inc.
4. Val-Matic Valve & Mfg. Corp.

B. Butterfly Valves: Subject to compliance with requirements, provide butterfly valves by one of the following:

1. Center Line Series 200 by Crane Co.; Crane Valve Group; Nibco BF 2500 (2000) or approved equal.

C. Globe Style Silent Check Check Valves: Subject to compliance with requirements, provide globe style silent check valves by following:

1. Style 900 by Metraflex Co; Nibco (F910B) Silent Check Valve; Val-Matic Silent Check Valve or approved equal.

2.2 VALVES, COMMON REQUIREMENTS

A. General: Refer to Part 3 “Valve Applications Schedule” Article for application schedule of valves, end connections, and actuator types.

B. Valve Sizes: Same as upstream pipe size, unless otherwise indicated.

C. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

D. Valve Threaded Ends: With threads according to ASME B1.20.1.

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

F. Material Substitution: Ductile iron is acceptable anywhere cast iron is specified, but cast iron is not acceptable where ductile iron is specified.

G. Class Substitution: If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

H. Chainwheel Operators: Where required, provide valve actuation assembly with ductile iron sprocket rim, brackets, and hot-dip galvanized steel chain; of type, number, size and fasteners as required for the host valve.

I. For piping systems required to be insulated, valve stems shall be extended to accommodate insulation. Refer to other Division 23 Sections for piping systems required to be insulated.

2.3 BALL VALVES

A. Liquid Service, Size NPS 2 (DN 50) and smaller:

1. General: Valve shall conform to MSS SP-110.
2. Minimum SWP rating: 150-psig (1035-kPa).
3. Minimum CWP rating: 600-psig (4140-kPa).
4. Body: ASTM B584 bronze, two-piece construction.
5. Ball: Type 316 stainless steel, full port for NPS 1 (DN 25) and smaller, full port otherwise.
6. Stem: Blowout-proof Type 316 stainless steel.
7. Seat/Packing: PTFE or TFE.
8. Ends: Threaded.
9. Handle: Vinyl-covered steel lever with memory stop; and zinc-plated steel nut.

2.4 BUTTERFLY VALVES

A. General: Valve shall conform to ANSI B16.34, and MSS SP68.

B. Minimum CWP rating:

1. 12 inch valves and below: 200-psig (1379-kPa).
2. Above 12 inch valves: 150-psig (1034-kPa).

C. Body and bonnet: ASTM A536 ductile-iron, extended neck. Cast iron valves will be rejected.

D. Packing: Field-replaceable EPDM seat and liner.

E. Bushing: PTFE.

F. Stem and Stem Hardware: Type 316 stainless steel.

G. Disc: Type 316 stainless steel.

H. End Connections: Lug and flanged bodies are acceptable; wafer bodies are not acceptable and will be rejected.

I. Dead End Service: All butterfly valves shall be suitable for bi-directional dead-end service without downstream blind flange. Bolt holes on lugged valve bodies shall be threaded per ANSI B-1.1 coarse thread, with center stop, to accept cap screws from both directionsf at 200-psig (1379-kPa).

J. Operator: Lever handle with ten-position latching mechanism, except where noted below.

1. Chainwheel Operators: Required for butterfly valves larger than NPS 4 (DN 100), if installed 96 inches (2400 mm) or higher above finished floor elevation.
2. Gear Actuator with Handwheel: Required for butterfly valves NPS 6 (DN 150) and larger, and for any butterfly valves larger than NPS 4 (DN 100) if installed 96 inches (2400 mm) or higher above finished floor elevation, to accommodate a chainwheel operator.

a. Actuators shall be ductile iron construction.
b. Product shall be Mastergear M Series, or equal as approved by Engineer.
c. All wheel handles shall be 18 inches in diameter.

2.5 CHECK VALVES

A. Globe Style Swing Check Valves, NPS 2½ (DN65) and larger: Valve shall conform to ANSI B16.1.

1. Minimum pressure rating: Class 125.
2. Body: ASTM A48, Cast-iron.
3. Seat: ASTM B584, Bronze.
4. Plug: ASTM B584, Bronze.
5. Spring: T304 Stainless Steel

6. Bushings: ASTM B584, Bronze.
7. Screws: T304 Stainless Steel

B. Bronze Swing Check Valve, NPS 2 (DN50) and smaller: Valve shall conform to MSS SP-80.

1. Minimum pressure rating: Class 150.
2. Body: ASTM B62 bronze body, y-pattern.
3. Bonnet: ASTM B62 bronze, threaded, removable for regrinding.
4. Disc and seat: Renewable; ASTM B62 bronze with bronze-alloy hinge pin.
5. Hardware: Bronze or bronze alloy.
6. Ends: Threaded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves as indicated, according to manufacturer’s written instructions.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install isolation valves at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

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

E. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

F. Install chainwheel operators where specified. Extend chains to within 60 inches (1520 mm) above finished floor elevation.

G. Install check valves for proper direction of flow.

3.3 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Threaded Connections: Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

1. Align threads at point of assembly.
2. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
3. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

C. Flanged Connections: Align flange surfaces parallel.

1. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. An anti-seize lubricant shall be applied to all bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
2. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.4 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.

3.5 VALVE APPLICATIONS SCHEDULE

A. General: Refer to piping Sections and Drawings for specific valve applications. If no specific valve type is indicated, use the valve types indicated in the following schedules.

B. HVAC Chilled Water, Condenser Water, HVAC Makeup Water and Drain Piping: Use the following types of valves.

1. For shutoff duty, NPS 2 (DN 50) and smaller, use ball valves.
2. For shutoff duty, NPS 2½ (DN 65) and larger, use butterfly valves.
3. For throttling duty, NPS 2 (DN 50) and smaller, use ball valves.
4. For throttling duty, NPS 2½ (DN 65) and larger, use butterfly valves.

5. For pump discharge protection, NPS 2½ (DN 65) and larger, use globe style silent check valves.

END OF SECTION 23 0523

SECTION 23 0529 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment, including but not limited to the following:

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

1.2 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. Section 23 0100 “Basic Mechanical Requirements,” and Section 23 0500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

C. The following Sections contain requirements that relate to this Section:
1. Division 23 Section “Mechanical Vibration Isolation” for vibration isolation devices.
2. Division 23 Section “Metal Ducts” for duct hangers and supports.

1.3 DEFINITIONS

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

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

1.4 PERFORMANCE REQUIREMENTS

A. If contractor elects to apply channel support systems and/or heavy-duty steel trapezes to support multiple pipes, in lieu of individual supports, then contractor is responsible for design of same capable of supporting combined weight of supported systems, system contents, and test water.
1. Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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

C. Do not suspend pipe hangers and supports from roof deck. Suspend such loads from structural steel only, and provide structural steel sub-framing as required.

D. Do not suspend piping loads exceeding 500 pounds within any 100 square feet of contiguous area from supported concrete floor slabs. Suspend such loads from structural members only, and provide structural steel sub-framing as required.

E. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

F. Do not suspend piping loads exceeding 500 pounds within any 100 square feet of contiguous area from supported concrete floor slabs. Suspend such loads from structural members only, and provide structural steel sub-framing as required.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated. Include:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Fastener systems.
4. Trapeze pipe hangers. Include Product Data for components.
5. Metal framing systems. Include Product Data for components.
6. Pipe stands. Include Product Data for components.

B. Shop Drawings: Shop drawings signed and sealed by a qualified professional engineer are required for the following custom pipe and equipment hangers and supports. Show fabrication and installation details and analysis data, and include calculations. Include Product Data for components.

1. All equipment stands and supports for equipment weighing 500 lbs (227 kg) or more.
2. Trapeze pipe hangers supporting an individual pipe larger than 12-inch (DN 300), two pipes larger than 8-inch (DN 200), three or four pipes larger than 6-inch (DN150), or any trapeze supporting five or more pipes of any size.
3. Metal framing systems supporting an individual pipe larger than 12-inch (DN 300), two pipes larger than 8-inch (DN 200), three or four pipes larger than 6-inch (DN150), or any trapeze supporting five or more pipes of any size.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M *Structural Welding Code – Steel*.

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications.”

C. ANSI/MSS Standard SP-58-2018 *Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation* including Amendment 1 Issued October 17, 2019, is hereby incorporated by reference. This Standard establishes:

1. Minimum requirements for materials, allowable stresses, product design, testing, and load ratings for pipe hanger and support assemblies for standard and unique pipe hangers and supports.
2. Inspection criteria for the manufacture and installation of pipe hangers and supports.
3. Required procedures for packing, marking, shipping, receiving, and storage of pipe hangers and supports.
4. Minimum requirements for pipe hanger and support assembly drawings.
5. Field practices for installation, adjustment, testing, and inspection of pipe hangers and supports.
6. Terminology and identification of pipe hangers and supports, along with recommended contractual relationship structures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manufactured Pipe Hangers:

   a. Anvil International, Inc.
   b. Cooper B-Line, Inc.
   c. Carpenter & Patterson, Inc.
   d. Erico International Corp.
   e. PHD Manufacturing, Inc.
   f. Tolco division of Cooper B-Line, Inc.

2. Metal Framing Systems:

   a. Anvil International, Inc.
   b. Cooper B-Line, Inc.
   c. Erico / Michigan Hanger Co.
   d. Thomas & Betts Corporation.
   e. Tolco division of Cooper B-Line, Inc.
   f. Unistrut Corporation; Tyco International, Ltd.

3. Thermal-Hanger Shield Inserts:

   a. Carpenter & Paterson, Inc.
   b. Erico International Corp.
   c. PHS Industries, Inc.
   d. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

4. Powder-Actuated Fastener Systems:

   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. Simpson Manufacturing Co.; Strong-Tie Anchor Systems Div.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Application: Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types, including special padding or coatings where required.

B. Carbon-Steel Pipe Hangers and Supports: MSS SP-58, Types 1 through 58, factory-fabricated components with pre-galvanized or hot dipped galvanized coatings. Include continuous-thread hanger rods, nuts, and washer made of carbon steel unless noted otherwise.

C. Stainless-Steel Pipe Hangers and Supports: MSS SP-58, Types 1 through 58, factory-fabricated components. Include continuous-thread hanger rods, nuts, and washer made of stainless steel unless noted otherwise.

D. Copper Pipe Hangers: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components. Include continuous-thread hanger rods, nuts, and washer made of stainless steel unless noted otherwise.

1. Riser Clamp: Riser clamps for insulated copper piping installed in a vertical configuration shall be a pre-engineered support meeting ANSI/MSS SP-58 Type 8; with carbon steel clamp and a thermoplastic polyolefin insert to support the weight of the riser pipe with insulation. Design shall provide insulation crush-resistance, maintain vapor barrier for below-ambient pipe services, and protect insulation ends from compression and tears. Capacity shall be not less than 320 pounds [145 kg] of vertical load. Comply with 25/50 Flame Spread/Smoke Development Index according to UL 2043 *Fire Test for Heat and Visible Smoke Release*.

E. Trapeze Pipe Hangers: Shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes, according to Standard MFMA-4. Galvanized steel construction if located indoors; stainless steel construction if located outdoors.

B. Channels: Continuous slotted steel channel with inturned lips.

C. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

D. Hanger Rods: As specified for Metal Pipe Hangers and Supports above.

E. Coatings: Galvanized hot dip only.
1. Metallic Coating: Hot-dipped galvanized after fabrication; All metal systems installed outside shall be metallic coated.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material: 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.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2-inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

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

B. High-Type, Single-Pipe Stand:
1. Description: Assembly of base, vertical and horizontal members, and pipe support.
2. Base: Stainless steel.
3. Vertical Members: Two or more stainless-steel, continuous-thread rods.
4. Horizontal Member: Stainless-steel rod with stainless-steel, roller-type pipe support.

C. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports.
2. Bases: One or more; stainless steel.
3. Vertical Members: Two or more stainless-steel channels.
4. Horizontal Member: Stainless-steel channel.
5. Pipe Supports: Stainless-steel, clevis-type pipe hangers.

2.7 MISCELLANEOUS MATERIALS

A. Structural and Miscellaneous Steel: As specified in Division 23 Section “Basic Mechanical Materials and Methods.”

B. Grout: As specified in Division 23 Section “Basic Mechanical Materials and Methods.”

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT SCHEDULE OF APPLICATIONS

A. Comply with MSS SP-58 for pipe hanger and trapeze selections and applications that are not specified in this Section.

B. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

D. Use copper-plated pipe hangers and copper or stainless-steel attachments, or use plastic coatings on attachments for electrolytic protection, where hangers are in direct contact with copper tubing.

E. Horizontal-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Unless otherwise indicated, choose among the following types:

1. Single Pipe Rolls (MSS Type 41): For suspension of pipes from two rods.
2. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes from single rod.
3. Complete Pipe Rolls (MSS Type 44): Where vertical adjustment is not necessary.
4. Adjustable Pipe Roll and Base Units (MSS Type 46): For vertical and lateral adjustment.
5. For any of the above, include protection saddles and/or shields as applicable, and as further specified under the heading “Protection of Insulated Piping” elsewhere in this section.
6. Exception: Piping whose normal operating temperature is less than 150ºF (e.g., chilled water, condenser water) may be supported with static hangers specified in the next paragraph.

F. Horizontal-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1).
2. Yoke-Type Pipe Clamps (MSS Type 2): For pipes NPS 4 and larger.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3).
4. Steel Pipe Clamps (MSS Type 4).

G. Horizontal-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1).
2. Yoke-Type Pipe Clamps (MSS Type 2): For pipes NPS 4 and larger.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3).
4. Steel Pipe Clamps (MSS Type 4).
5. Adjustable Steel Band Hangers (MSS Type 7): For pipes up to NPS 2 only.
6. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For pipes up to NPS 2 only.
7. U-Bolts (MSS Type 24).

H. Vertical-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Use spring hangers and supports. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports shall include the following types:

1. Horizontal (MSS Type 54): Mounted horizontally.
2. Vertical (MSS Type 55): Mounted vertically.
3. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

I. Vertical-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8). Use pre-engineered riser clamp with TPO insert for insulated copper piping as specified in Part 2 of this Section.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.

J. Vertical-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.

K. Hanger-Rod Attachments: Unless otherwise indicated, choose among the following types:

1. Steel Turnbuckles (MSS Type 13).
2. Steel Clevises (MSS Type 14).
3. Malleable-Iron Sockets (MSS Type 16).
4. Steel Weldless Eye Nuts (MSS Type 17).

L. Building Attachments: Unless otherwise indicated, choose among the following types:
1. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
2. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams.
3. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
4. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
5. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
6. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
7. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to concrete ceiling.

M. Horizontal-Piping Hangers and Supports for the first three hangers/supports or the first 50-feet (whichever is greater) adjacent to Pumps and Chillers: Use spring hangers and supports. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports shall include the following types:
1. Horizontal (MSS Type 54): Mounted horizontally.
2. Vertical (MSS Type 55): Mounted vertically.

3. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
4. Exception: Spring hangers are not required adjacent to inline pumps that are smaller than 5-horsepower. Use other types of hangers and supports as listed for service below.

3.2 HANGER AND SUPPORT MAXIMUM SPACING AND MINIMUM ROD SIZE

A. Install hangers and supports with the following maximum spacing and minimum rod sizes.

B. Flanged, Threaded, or Welded Steel Piping for any Liquid-service piping systems:

1. NPS ¾ (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8-inch (10 mm).
2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8-inch (10 mm).
3. NPS 1¼ (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8-inch (10 mm).
4. NPS 1½ (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
5. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8-inch (10 mm).
6. NPS 2½ (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 1/2-inch (13 mm).
7. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2-inch (13 mm).
8. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 5/8-inch (16 mm).
9. NPS 5 (DN 125): Maximum span, 17 feet (5.2 m); minimum rod size, 3/4-inch (19 mm).
10. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 3/4-inch (19 mm).
11. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 7/8-inch (22 mm).
12. NPS 10 (DN 250): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
13. NPS 12 (DN 300): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
14. NPS 14 (DN 350): Maximum span, 20 feet (6.1 m); minimum rod size, 1-inch (25 mm).
15. NPS 16 (DN 400): Maximum span, 20 feet (6.1 m); minimum rod size, 1-inch (25 mm).
16. NPS 18 (DN 450): Maximum span, 20 feet (6.1 m); minimum rod size, 1¼-inches (32 mm).
17. NPS 20 (DN 500): Maximum span, 20 feet (6.1 m); minimum rod size, 1¼-inches (32 mm).
18. NPS 24 (DN 600): Maximum span, 20 feet (6.1 m); minimum rod size, 1¼-inches (32 mm).

C. Drawn-Temper Copper Piping for any liquid-service piping systems:

1. NPS ¾ (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 3/8-inch (10 mm).
2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8-inch (10 mm).
3. NPS 1¼ (DN 32): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8-inch (10 mm).
4. NPS 1½ (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).
5. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).

D. Polypropylene, CPVC and PVC Piping for any service:

1. NPS ¾ (DN 20): Maximum span, 3 feet (0.9 m); minimum rod size, 3/8-inch (10 mm).
2. NPS 1 (DN 25): Maximum span, 3 feet (0.9 m); minimum rod size, 3/8-inch (10 mm).
3. NPS 1¼ (DN 32): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
4. NPS 1½ (DN 40): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
5. NPS 2 (DN 50): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
6. NPS 2½ (DN 65): Maximum span, 4 feet (1.2 m); minimum rod size, 1/2-inch (13 mm).

7. NPS 3 (DN 80): Maximum span, 4 feet (1.2 m); minimum rod size, 1/2-inch (13 mm).
8. NPS 4 (DN 100): Maximum span, 4 feet (1.2 m); minimum rod size, 5/8-inch (16 mm).

E. Rod diameters may be reduced one size for double-rod hangers, with 3/8-inch (10 mm) minimum rods.

F. Hanger and support spacing for piping and tubing not listed above shall be according to MSS SP-58 and piping manufacturer's written instructions.

3.3 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M. All systems shall have hot-dip galvanized protection applied as described above. Field applied is not acceptable. Items where hot-dip galvanized protection is damaged shall be removed and replaced at the Contractor's cost per the Owner's representative discretion.

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

D. Thermal-Hanger Shield Installation: Required for insulated piping NPS 4 and larger if piping operates below surrounding ambient air temperature.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal movement of piping systems.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2½ (DN 65) 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. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to attach hangers and supports, so as to maintain an equivalent insulation or fire rating as existed without said hanger or support attachment.

L. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4-inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

M. Pipe Stand Installation:
1. Pipe Stand Types: Assemble components and mount on smooth level surface.

3.4 PROTECTION OF INSULATED PIPING:

A. Attach clamps and spacers to piping.

1. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

B. Do not exceed pipe stress limits according to ASME B31.9.

C. Piping Operating above Ambient Air Temperature: Clevis- and clamp-type supports shall project through insulation, with pipe support making direct contact with pipe and with insulation applied in a manner that encapsulates the clevis or clamp. For piping on roller-type supports, install MSS SP-58, Type 39 protection saddles, and fill interior voids with insulation that matches adjoining insulation.

1. Contractor's Option: In lieu of the above paragraph, contractor has the option of complying with the same specifications as for "Piping Operating below Ambient Air Temperature" in the following paragraphs.

D. Piping Operating below Ambient Air Temperature: Clevis- and clamp-type supports shall be sized for the outside diameter of the insulation including jacket. Install MSS SP-58, Type 40 protective metal shields. Shields shall span an arc of 180 degrees.

1. Pipe Sizes NPS 4 (DN 100) and larger: Include thermal-hanger shield inserts. Insert shall be same thickness as adjoining pipe insulation and length shall be at least as long as the protective shield. Include steel weight-distribution plate if pipe is installed on rollers.
2. Metal Shield Dimensions for Pipe: Not less than the following:

a. NPS 3½ (DN 90) and smaller: 12-inches (300 mm) long and 0.048-inch (1.22 mm) thick.
b. NPS 4 (DN 100): 12-inches (300 mm) long and 0.06-inch (1.52 mm) thick.

c. NPS 5 and NPS 6 (DN 125 & 150): 18-inches (450 mm) long and 0.06-inch (1.52 mm) thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): 24-inches (610 mm) long and 0.075-inch (1.91 mm) thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): 24-inches (610 mm) long and 0.105-inch (2.67 mm) thick.

3. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

E. Shield Dimensions for Pipe: Not less than the following:
1. NPS ¼ to NPS 3½: 12 inches long and 0.048 inch thick.
2. NPS 4: 12 inches long and 0.06 inch thick.
3. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
4. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

3.5 EQUIPMENT SUPPORTS

A. All systems shall have hot-dip galvanized protection applied as described above. Hot-dip galvanized protection shall be applied only after final welding and finishing is complete. Field applied is not acceptable. Items where hot-dip galvanized protection is damaged shall be removed and replaced at the Contractor's cost per the Owner's representative discretion.

B. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

C. Grouting: Place grout under supports for equipment and make bearing surface smooth.

D. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
5. All systems shall have hot-dip galvanized protection applied as described above. Hot-dip galvanized protection shall be applied only after final welding and finishing is complete. Field applied is not acceptable. Items where hot-dip galvanized protection is damaged shall be removed and replaced at the Contractor's cost per the Owner's representative discretion.

3.7 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Trim excess length of continuous-thread hanger and support rods to 1½-inches (40 mm).

3.8 PAINTING

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

B. 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. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

C. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 23 "Basic Mechanical Materials & Methods."

END OF SECTION 23 0529

SECTION 23 0540 – MECHANICAL VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes vibration isolation pads, mounts, and hangers for mechanical and HVAC services.

1.2 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. Section 23 0100 “Basic Mechanical Requirements,” and Section 23 0500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

C. The following Sections contain requirements that relate to this Section:
1. Division 23 Section “Basic Mechanical Materials and Methods” for flexible pipe connectors.
2. Division 23 Section “Hangers and Supports” for pipe hanger restraints.
3. Division 23 Section “Metal Ducts” for flexible duct connectors.

1.3 SUBMITTALS

A. Product Data: types, styles, materials, and finishes for each type of isolator specified. Include load deflection curves for each vibration isolation device.

1.4 QUALITY ASSURANCE

A. Single-Source: All vibration isolation devices shall be the product of a single manufacturer.

B. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code – Steel.”

1.5 COORDINATION

A. Coordinate layout and installation of vibration isolation devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in Division 20 Section “Seismic Protection.” Single-source responsibility

is required; the contractor shall furnish products under Division 20 Section "Seismic Protection" and under this Section by the same manufacturer.

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

1. California Dynamics Corp.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. Tolco division of Eaton/Cooper.
5. Vibration Eliminator Co., Inc.
6. Vibro-Acoustics, Inc.
7. The VMC Group; Amber/Booth, Korfund, and VMC brands.

C. Model numbers by Mason Industries, Inc. are listed below to establish the level of quality required; equal products by other listed manufacturers are acceptable under the "Material and Equipment Selection" terms of Division 23 Section "Basic Mechanical Requirements."

D. All neoprene referred to hereinafter shall be oil resistant, compounded for not greater than 65 durometer, minimum tensile strength of 2000 psi, minimum elongation of 300%, and maximum compression set at 25% of the original deflection.

E. Where exposed to the atmosphere, all steel shall be hot dipped galvanized unless noted otherwise.

F. All hardware shall be cadmium plated, and all springs shall be neoprene coated.

2.2 VIBRATION ISOLATORS

A. Elastomeric Isolator Pads (Schedule Designation Type 1): Oil and water resistant and factory cut to sizes that match requirements of the equipment supported. Load range from 10 to 50 psig (69 to 345 kPa) and a deflection not less than 0.08-inch per 1-inch (2 mm per 25 mm) of thickness. Do not exceed a loading of 50 psig (345 kPa). Neoprene arranged in single or multiple layers, molded with a non-slip ribbed or waffled pattern, and steel baseplates of sufficient stiffness to provide uniform loading over the pad area. Provide 5/16-inch minimum thickness. Provide 1/16-inch galvanized steel plate between multiple layers. Model MBSW by Mason Industries, Inc.

B. Elastomeric Mounts (Schedule Designation Type 2): Double-deflection type, with molded, neoprene isolator elements, with encapsulated top- and baseplates. Factory-drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range. Model ND by Mason Industries, Inc.

C. Restrained Elastomeric Mounts (Schedule Designation Type 2R): All-directional elastomeric mountings with seismic restraint. Model RBA/RCA by Mason Industries, Inc.

1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators (Schedule Designation Type 3): Freestanding, laterally stable, open-spring-type isolators. Design and install such that ends of springs remain parallel. Model SLF by Mason Industries, Inc.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 1.2 times the rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to ½-inch- (13-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig (690 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators (Schedule Designation Type 4): Same as Spring Isolators specified above, plus the following: Welded steel housing with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Provide adjustable equipment mounting and leveling bolt. Unit shall be capable of supporting equipment at a fixed elevation during equipment erection. Model SLR by Mason Industries, Inc.

F. Elastomeric Hangers (Schedule Designation Type 2H): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Model HD by Mason Industries, Inc.

G. Spring Hangers (Schedule Designation Type 3H): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression. Model 30N by Mason Industries, Inc.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

H. Spring Hangers with Vertical-Limit Stop (Schedule Designation Type 3HR): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop. Model PC30N by Mason Industries, Inc.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer “up-stop” on lower threaded rod.

2.3 FACTORY FINISHES

A. Manufacturer’s standard prime-coat finish ready for finish painting.

B. Finish: Manufacturer’s standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Install vibration control products in accordance with manufacturer’s written instructions. Positive attachment of vibration control products to the isolated equipment is required. Positive attachment of vibration control products to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.

C. Install resilient bolt isolation washers on equipment anchor bolts.

3.2 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.3 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.4 VIBRATION ISOLATOR SCHEDULE

A. All of the Vibration Isolators Scheduled are field-supplied and field-installed external to the respective equipment unit. See each individual Division 23 specification section for additional factory-installed Vibration Isolators internal to each respective equipment unit.

B. Supported Equipment: Packaged Liquid Chiller.
   1. Equipment Location: Chiller Room.
   2. Isolator Type: Elastomeric Isolator Pads.
   3. Base Type: None
   4. Minimum Deflection: 0.1-inch.

C. Supported Equipment: Tower pump.
   1. Equipment Location: Chiller Room.
   2. Isolator Type: Elastomeric Isolator Pads.
   3. Base Type: None
   4. Minimum Deflection: 0.1-inch.

END OF SECTION 23 0540

SECTION 23 0700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes mechanical insulation for ductwork, equipment, piping, and other installations, including the following:

1. Insulation Materials:
   a. Flexible elastomeric
   b. Mineral fiber
2. Insulating cements
3. Adhesives
4. Mastics
5. Sealants.
6. Factory-applied jackets.
7. Field-applied jackets.
8. Tapes and securements.
9. Corner angles.

1.2 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. Section 23 0100 “Basic Mechanical Requirements,” and Section 23 0500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. SSL: Self-sealing lap.

D. Thermal Resistivity: “R-values” represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1-inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one BTU to flow through one square foot of material, in one hour, at a given mean temperature.

E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

F. Exposed Installations: Exposed to view. Examples include finished occupied spaces without ceilings, mechanical equipment rooms, courtyards and rooftop locations.

G. Concealed Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings or within duct shafts.

H. Conditioned Space: Spaces that are served by both a mechanical heating and mechanical cooling system are conditioned spaces. Heating-only spaces are not conditioned spaces. The space above a ceiling is considered conditioned space if the space directly below that ceiling is conditioned space. A vertical shaft is considered conditioned space if the spaces on all sides surrounding the shaft are conditioned spaces.

1.4 SUBMITTALS

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

B. MSDS (Material Safety Data Sheet) for each adhesive, mastic, sealant, and cement furnished.

C. Shop Drawings: Show details for the following:

1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Insulation application at pipe expansion joints for each type of insulation.
3. Insulation application at elbows, fittings, flanges, valves, couplings, and specialties for each type of insulation.
4. Removable insulation at piping specialties, equipment connections, and access panels.
5. Application of field-applied jackets.
6. Application at linkages of control devices.
7. Field application for each equipment type.
8. Indicate colors to be used for all locations where PVC jacketing is to be used, and identify pipe service.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. <u>All pipe coverings shall match similar to existing pipe covers installed at East Campus Chiller Plant. Coordinate with Owner's Representative any and all samples required.</u>

2. Preformed Pipe Insulation Materials: 12-inches (300 mm) long by NPS 2 (DN 50).
3. Sheet Form Insulation Materials: 12-inches (300 mm) square.
4. Jacket Materials for Pipe: 12-inches (300 mm) long by NPS 2 (DN 50).
5. Sheet Jacket Materials: 12-inches (300 mm) square.
6. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
7. PVC jacketing shall match existing installed throughout existing East Campus Chiller Plant.

E. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.

F. 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.

G. Field quality-control inspection reports.

1.5 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. Fire-Test-Response Characteristics: Insulation and related materials shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Exception: Flame-spread index of 25 or less, and smoke-developed index of 150 or less; is acceptable for insulation not installed in an air-handling duct, plenum, space above ceilings if used as a return air plenum, or air-handling equipment rooms if used as a return/exhaust/relief air plenum, or any other air-handling situation.

1.6 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.

B. All of the insulation materials and accessories covered by this Specification shall be delivered to the Site and stored in a safe, dry place.

C. Contractor shall use whatever means necessary to protect the insulation material and accessories before, during, and after installation. No insulation material shall be installed that has been become damaged in any way. Contractor shall also use all means necessary to protect work and materials installed by others.

D. If any insulation material has become wet because of transit or Site exposure to moisture or water, Contractor shall not install such material, and shall remove it from the Site.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section “Hangers and Supports.”

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and 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. All carbon steel piping shall have an epoxy paint applied to the entire system prior to any liquid entering system and before any insulation is applied to piping system.
   1. Provide Exterior High-Performance Coating by Sherman-Williams Company (The), Benjamin Moore & Co. or PPG Architectural Coatings. Steel Substrates: Epoxy System MPI EXT 5.1F, Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI#101; Intermediate Coat: Epoxy, high build, low gloss, MPI#108; Topcoat: Epoxy, gloss, MPI#77. Coordinate with Division 23 Specification section 232113 Hydronic Piping.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   1. Flexible Elastomeric Insulation:

      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP/Armaflex.
      c. K-Flex USA; Insul-Lock® Seam-Seal.
      d. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

   2. Mineral Fiber Insulation:

      a. CertainTeed Corp.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.

   3. Insulating Cements: Same as insulation manufacturer, or

      a. Insulco, Division of MFS, Inc.
      b. P. K. Insulation Mfg. Co., Inc.
      c. Rock Wool Manufacturing Company.

   4. Sealants, Adhesives and Mastics: Same as insulation manufacturer, or

      a. H.B. Fuller Construction Products Inc. (Childers and/or Foster brands)
      b. ITW TACC, Division of Illinois Tool Works.
      c. Marathon Industries, Inc.

d. Mon-Eco Industries, Inc.
e. Vimasco Corporation.

5. Field-Applied Jackets: Same as insulation manufacturer, or
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. Johns Manville; Zeston.
   c. PABCO Metals Corporation; Surefit.
   d. P.I.C. Plastics, Inc.
   e. Proto PVC Corporation.
   f. RPR Products, Inc; Insul-Mate.
   g. Speedline Corporation.

6. Tapes: Same as insulation manufacturer, or

   a. Avery Dennison Corporation, Specialty Tapes Division.
   b. Compac Corp.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Polyguard Products, Inc.
   e. Venture Tape.

2.2 INSULATION MATERIALS

A. Refer to Schedule in Part 4 for requirements about where insulating materials shall be applied.

B. Restrictions: Products shall not contain asbestos, lead, mercury, or mercury compounds. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

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. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

D. Adhesives shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.

   1. Thermal Conductivity: 0.28 average maximum at 75ºF mean temperature using test method ASTM C177 or C518.
   2. Water Vapor Permeability: Maximum 0.1 perm-inch using test method ASTM E96 Procedure A.
   3. Water Absorption: Maximum 0.2% by volume using test method ASTM C209.
   4. Product shall pass mold growth, fungi resistance, and bacterial resistance tests per UL 181, ASTM G21, G22, and C1338.
   5. Adhesive: Comply with MIL-A-24179A, Type II, Class I; VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied jacket.

1. Thermal Conductivity: 0.26 average maximum at 75°F mean temperature.
2. Density: 1.5 lb/cf (24-kg/cu. m) minimum.
3. Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB.

1. Thermal Conductivity: 0.26 average maximum at 75°F mean temperature.
2. Density: 2.0 lb/cf (32-kg/cu. m) minimum.
3. Jacket (Ducts): Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. Jacket (Equipment): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

H. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850ºF (454ºC); mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied jacket.

1. Thermal Conductivity: 0.26 average maximum at 75°F mean temperature.
2. Jacket: White, polypropylene-coated kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I; with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip. Example of acceptable product is Owens-Corning ASJ Max-SSL or Johns Manville Micro-Loc HP Ultra.
3. Adhesive: Water-based and complying with ASTM C916 Type II; equal to Foster 85-60 and/or Childers CP-127.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB.

1. Thermal Conductivity: 0.29 average maximum at 100°F mean temperature.
2. Density: 2.5 lb/cf (40-kg/cu. m) minimum.
3. Jacket: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I
4. Adhesive: Water-based and complying with ASTM C916 Type II.

2.3 CEMENTS AND MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates. Comply with ASTM C755-19 *Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation* Table 2, for the selection of vapor retarder systems.

B. Insulating Cements: Select one or more of the following at contractor’s option.

1. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below-ambient services, for applications on seams, punctures, penetrations, and terminations of vapor retarder membranes. Equal to Foster 30-80 or Childers CP-35 or Vimasco 749.

1. Water-Vapor Permeance, Piping and Equipment: ASTM E96-16, Procedure A (desiccant method), 0.15 perms.
2. Water-Vapor Permeance, HVAC Ducts: ASTM E96-16, Procedure A (desiccant method), 1.0 perms.
3. Service Temperature Range: -20 to +180ºF (-29 to +82ºC).
4. Solids Content: ASTM D1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services. Equal to Foster 46-50 or Childers CP-10/11 or Vimasco WC-5.

1. Water-Vapor Permeance: ASTM F1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: -20 to +200ºF (-29 to +93ºC).
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. Color: White.

2.4 SEALANTS

A. Joint Sealants: Permanently flexible, elastomeric sealant. Materials shall be compatible with insulation materials, jackets, and substrates.

1. Service Temperature Range: -100 to +200ºF (-73 to +94ºC).
2. Color: White, tan, or gray.
3. VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants: Fire- and water-resistant, flexible, elastomeric sealant. Materials shall be compatible with insulation materials, jackets, and substrates.

1. Service Temperature Range: -40 to +250ºF (-40 to +121°C).
2. Color: Aluminum.
3. VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants: Fire- and water-resistant, flexible, elastomeric sealant. Materials shall be compatible with insulation materials, jackets, and substrates.

1. Service Temperature Range: -40 to +250ºF (-40 to +121°C).
2. Color: White.

3. VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness 30 mils (0.8 mm); roll stock ready for shop or field cutting and forming.

1. Adhesive: Compatible with PVC, as recommended by jacket material manufacturer.
2. Color: Color-coded jackets based on system.
   a. Chilled Water: Match green color installed within existing East Campus Chiller Plant.
   b. Domestic Water: Match blue color installed within existing East Campus Chiller Plant.
   c. All other systems: Color as selected by Engineer.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
4. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

C. Metal Jackets: Sheet and roll stock ready for shop or field sizing. Factory pre-cut and rolled to size is also acceptable.

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105 or 5005, Temper H-14. Finishes and thickness as follows:

   a. Indoor Ducts and Plenums: Smooth, 0.016-inch (0.41 mm) thick.
   b. Indoor Equipment: Stucco Embossed, 0.016-inch (0.41 mm) thick.
   c. Outdoor Ducts, Equipment, and Piping: Stucco embossed, with Z-shaped locking seam, 0.024-inch (0.61 mm) thick.

2. Stainless-Steel Jacket: ASTM A167 or ASTM A240; Type 304 stucco embossed, with Z-shaped locking seam; 0.016-inch (0.41 mm) thick.
3. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:
   a. Same material, finish, and thickness as jacket; provide as required for preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows, tee covers, flange and union covers, end caps, beveled collars, and valve covers.
   b. Field-fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136 and UL listed.

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 percent.
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.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136 and UL listed.

1. Width: 3-inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2-inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Width: 2-inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.7 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1-inch (25 by 25 mm), PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch (1.0 mm) thick, minimum 1 by 1-inch (25 by 25 mm), aluminum according to ASTM B209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024-inch (0.61 mm) thick, minimum 1 by 1-inch (25 by 25 mm), stainless steel according to ASTM A167 or ASTM A240, Type 304 or 316.

PART 3 - EXECUTION

3.1 GENERAL

A. The configurations of installed insulation and jacketing materials shall comply with the application recommendations of the MICA National Commercial and Industry Insulation Standards (hereinafter referred to as "MICA Standards") and this Specification. In case of conflict, this Specification shall have precedence.

3.2 EXAMINATION

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

3.3 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a

C. corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 ºF (60 and 149°C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300ºF (0 and 149°C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.4 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and 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. Install multiple layers of insulation with longitudinal and end seams staggered.

E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer. Install insulation with least number of joints practical.

H. 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.

I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

J. 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 1½-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.
4. For below ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

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

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

M. 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.

N. At the following locations, omit jacket and provide a separate cutaway removable segment of insulation clearly labeled "Access." For below-ambient services, provide a design that allows access but maintains vapor barrier.

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.5 PENETRATIONS

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

3.6 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. See Part 4 Insulation Schedules for specific requirements.

B. Where required, secure blanket or board insulation to equipment, tanks and vessels with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels. Do not weld anchor pins to ASME-labeled pressure vessels. Select insulation hangers and adhesive that are compatible with service temperature and with substrate. On tanks and vessels, maximum anchor-pin spacing is 3-inches (75 mm) from insulation end joints, and 16-inches (400 mm) o.c. in both directions. Do not over-compress insulation during installation. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels. Impale insulation over anchor pins and attach speed washers. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6-inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12-inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable

radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48-inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3-inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

C. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive. Seal longitudinal seams and end joints.

D. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum or stainless steel, at least 0.040-inch (1.0 mm) thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.7 PIPE INSULATION INSTALLATION

A. See Part 4 Insulation Schedules for specific requirements.

B. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

C. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. If furnished in half sections, orient longitudinal joints at 3 and 9 o'clock positions on the pipe.
2. All insulation shall be tightly butted and free of voids and gaps at all joints.
3. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
4. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6-inches (150 mm) o.c.
5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. Vapor barrier must be continuous.

D. Insulation Installation on Pipe Flanges or Mechanical Couplings:

1. Install preformed pipe insulation to outer diameter of pipe flange or mechanical coupling (such as grooved pipe couplings, if applicable).
2. Make width of insulation section same as overall width of flange/coupling and bolts, plus twice the thickness of pipe insulation, not to exceed 1½-inch (38-mm) thickness.
3. Fill voids between inner circumference of flange/coupling insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch (25 mm), and seal joints with flashing sealant.

E. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
3. Cut sectional pipe insulation to fit. 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.

F. Insulation Installation on Valves, Strainers, Unions, and Specials:

1. 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.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation over valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
4. 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.
5. Insulate 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.
6. 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.

7. 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.
8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

G. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. 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.

H. 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.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

I. Special Requirements for Flexible Elastomeric Insulation Installation: Seal all transverse seams, longitudinal seams, end joints, and section joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. See Part 4 Insulation Schedules for specific requirements.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12-inches (300 mm) o.c. and at end joints.

3.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

PART 4 - SCHEDULES

4.1 INSULATION SCHEDULES

A. Furnish and install duct, equipment, and piping insulation as specified above and in accordance with the schedules below. All insulation thicknesses and pipe sizes in the following tables are given in nominal inches. Where more than one type of allowable material or more than one type of field jacket is listed, the choice is contractor’s option.

B. Hot Surfaces: For piping, ductwork, and equipment services denoted as 105ºF or greater, all piping surfaces including but not limited to pipe, duct, flanges, fittings, valves of every kind, pumps, dampers, strainers, unions, steam traps, and other appurtenances shall be insulated to avoid potential for personnel injury via contact with hot surface.

C. Cold Surfaces: For piping, ductwork, and equipment surfaces operating below surrounding ambient temperature, all surfaces including but not limited to pipe, duct, flanges, fittings, valves of every kind, pumps, dampers, strainers, unions, and other appurtenances shall be insulated and shall include uninterrupted vapor barrier to avoid potential condensation.

EQUIPMENT INSULATION Item / Description	Service	Location	Size	Allowable Materials	Insulation Thickness	Field Jacket	Keyed Notes
HVAC Pump (existing chilled water pump)	Chilled Water	Indoors	Any	FE	1.00	---	

LEGEND:

FE Flexible Elastomeric

EQUIPMENT INSULATION Item / Description	Service	Location	Size	Allowable Materials	Insulation Thickness	Field Jacket	Keyed Notes
New Chiller (CH-9) All components associated with evaporator including hinged doors.	Chilled Water	Indoors	Any	FE	1.5	---	
Existing Chiller Pump (HXP-1)	Chilled Water	Indoors	Any	FE	1.00	---	

LEGEND:

FE Flexible Elastomeric

PIPE INSULATION Services	Temperature Range °F	Size Range	Location	Allowable Materials	Thick-ness	Field Jacket	Keyed Notes
Equipment drains, blowdown, hot vents, coil condensate, makeup or fill water	below 60	¾ to 1¼	Indoors	FE	0.50	---	
		1½ & up	Indoors	MF	1.00	PVC	(2)
	above 105	All	All	MF	1.50	AL,SS	(1)
Chilled Water Piping (supply and return)	below 40	¾ to 6	Indoors	FE	2.00	PVC	(2), (3), (4)
		8 & up	Indoors	FE	2.00	PVC	(2), (3), (4)

KEYED NOTES:

(1) *The specified field jacket is required only if outdoors.*

(2) *The specified field jacket is required on piping and fittings. Field jacket shall match existing systems.*

(3) *Vapor Retarder Required.*

(4) *Finish: Paint pipe with epoxy coat primer prior to application of insulation.*

LEGEND:

AFF	Above Finished Floor		
FE	Flexible Elastomeric		
MF	Mineral Fiber	AL	Aluminum
PVC	Polyvinyl Chloride	SS	Stainless Steel

END OF SECTION 23 0700

SECTION 23 0900 - CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. University of Missouri-Columbia EMCS Controls Specification.

B. This section contains requirements for electric and digital control systems as indicated on the contract drawings.

C. 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).

D. DDC systems consist of Johnson Controls METASYS controllers. Contractor shall install owner provided control enclosures. Owner will provide and install controllers. 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. Owner shall disconnect, tag and remove all controllers where device is called out to be re-used on sheet M701.

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.

1.2 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Special Conditions apply to work of this section.

1.3 QUALITY ASSURANCE

A. 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 Condition's section 3.4.1 and 3.4.4.

B. Codes and Standards:

1. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.
2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for control systems.

3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
4. NFPA Compliance: Comply with NFPA 70 "National Electric Code".

1.4 SUBMITTALS

A. Shop Drawings: Submit shop drawings for each control system, containing the following information:

B. Product data for each damper, valve, and control device.

C. Schematic flow diagrams of system showing fans, pumps, coils, dampers, valves, and control devices.

D. Label each control device with setting or adjustable range of control.

E. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

F. Provide details of faces on control panels, including controls, instruments, and labeling.

G. Include written description of sequence of operation.

H. Provide wiring diagrams of contractor provided interface and I/O panels.

I. Provide field routing of proposed network bus diagram listing all devices on bus.

J. Provide parts manual for all control valves and actuators. Manuals shall have drawings showing all associated parts corresponding label with part number of each type of valve and actuator.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Air Piping:

1. Copper Tubing: Seamless copper tubing, Type M or L, ASTM B 88; wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment.
2. Flex Tubing: Virgin Polyethylene non-metallic tubing, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on polyethylene fittings. Tubing used above suspended ceilings to be plenum rated per NFPA 90A. See section 3.1.b for locations where flex tubing can be used.
3. Copper to polyethylene connections shall be compression barbed fittings or solder barbed fittings.

B. Conduit and Raceway:

1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.

2. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.
3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment.
4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.

C. Air and Hot Water Electronic Temperature Sensors:

1. All electronic temperature sensors shall be compatible with Johnson METASYS systems.
2. Sensors shall be 1,000 ohm platinum, resistance temperature detectors (RTDs) with two wire connections. Duct mounted sensors shall be averaging type. Contractor may install probe type when field conditions prohibit averaging type, but must receive permission from Owner's Representative.
3. Coordinate thermowell manufacturer with RTD manufacturer. Thermowells that are installed by the contractor, but are to have the RTD installed by owner, must be Johnson Controls Inc. series WZ-1000.

D. Electronic Temperature Sensors and Transmitters:

1. Chilled Water, Tower Water, Heating Hot Water, and Steam Temperature Sensors

a. 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.
b. 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.
c. RTD:

1) RTD type: 2-wire or 3-wire 100 ohm platinum class A
2) Outside Diameter: 0.25 inch
3) Tolerance: +/- 0.06% Type A
4) Stability: +/- 0.1 % over one year.
5) TCR: 0.00385 (ohm/ohm/ºC).
6) RTD shall be tip sensitive.
7) Resistance vs. Temperature table for the RTD must be provided to the Owner.

d. Transmitter:

1) Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
2) Type: 2 wire (loop powered)
3) Input: 2 or 3 wire 100 ohm platinum class A or class B RTD
4) Output: Output shall be a 4-20 mA signal linear to temperature
5) Calibrated Span:

a) Chilled Water: 30ºF to 130 ºF.

b) Tower Water: 30 ºF to 130ºF.
c) Hot Water: 100ºF to 250 ºF.
d) Steam: 150 ºF to 450 ºF.

6) 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 ºF, whichever is greater.
7) Supply Voltage: 24 VDC.
8) Ambient Operating Temp.: 32 to 122 ºF
9) Epoxy potted for moisture resistance.
10) Mounting: Transmitter shall be mounted in the RTD connection head.

e. Thermowell

1) Thermowell shall be suitable for immersion in chilled/hot water and steam.
2) Thermowell shall be reduced tip.
3) Thermowell shall be one piece stainless steel machined from solid bar stock.
4) Thermowell shall have 1/2" NPT process connection to pipe thred-o-let.
5) Thermowell Insertion depth shall be ½ the inside pipe diameter but not to exceed 10".

f. Assembly:

1) Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.
2) 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.

g. RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:

1) Manufacturer: Pyromation, Inc.
2) Chilled Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(30-130)F with calibration SMC(40,60)F
3) Tower Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(5130)F with calibration SMC(55,85)F
4) Hot Water: RAF185L-S4C[length code]08T2-SL-8HN31,TT440-385U-S(100-250)F with calibration SMC(140,180)F
5) Steam: RAT185H-S4C[length code]08T2-SL-8HN31,TT440-385U-S(150-450)F with calibration SMC(300,350)F

E. Occupant Override: Provide wall mounted occupant override button in locations shown on drawings.

F. Fan/Pump Status: Status points for fan or pump 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 and pump 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. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty.

a. Kele, Hawkeye or approved equal.

G. Relays Used for Fan and Pump Start/Stop: Must have LED indication and be mounted externally of starter enclosure or VFD

1. Kele, RIBU1C or approved equal.

H. 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. Kele, DCPA-1.2 or approved equal

I. Pressure Differential Switch:

1. Fans: NECC model DP222 or approved equal.

2.2 CONTROL VALVES AND VALVE ACTUATORS

A. Control Valves: Provide factory fabricated electric control valves of type, body material, and pressure class indicated as indicated on the drawings. Butterfly style control valves are acceptable for modulating service where shown on plans. Equip control valves with heavy-duty electric actuators, with proper shutoff rating for each individual application. All control valves shall be line size only.

B. Actuator Manufacturers: Subject to compliance with requirements, provide large-valve actuators by Rotork Controls Inc. Provide Rotork IQT direct drive quarter-turn electric actuators.

1. Large-Valve Actuator: As used in this subsection, “large valve” means any control valve actuator on NPS 2 ½ (DN 65) and larger valves Actuators shall be Rotork IQT direct drive quarter-turn electric actuators only.

a. The actuators shall be suitable for use on a nominal 480 volt, 3 phase, 60 Hz power supply and are to incorporate motor, integral reversing starter, local control facilities and terminals for remote control and indication connections housed within a self container, sealed enclosure.
b. As a minimum the actuators should meet the requirements set out in EN15714-2 and ISA SP96.02.
c. In order to maintain the integrity of the enclosure, setting of the torque levels, position limits and configuration of the indication contacts etc. shall be carried out without the removal of any actuator cover and without mains power over an Infra red or Bluetooth wireless interface. Sufficient commissioning tools shall be provided with the actuators and must form an integral part of the actuator and must be removable for secure storage. In addition, provision shall be made for the protection of configured actuator settings by a means independent of access to the commissioning tool.

d. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

e. Electronic Operators: Select operator for full shutoff at maximum pump differential pressure and temperature. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.

f. Actuators shall be suitable for outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from -33 degrees C (22 degrees F) to 70 degrees C (140 degrees F), up to 100% relative humidity.

g. Actuator shall be o-ring sealed, watertight to IP66/IP68 7m for 72 hours, NEMA 7, 6. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed for site cabling, the terminal compartment having the same ingress protection rating of the actuator with the terminal cover removed.

h. Enclosure must allow for temporary site storage without the need for electrical supply connection. All external fasteners shall be plated stainless steel. The use of an un-plated stainless steel or steel fasteners is not permitted.

i. The motor shall be integral part of the actuator, designed specifically for valve actuator applications. It shall be a low inertia high torque design, class F insulated with a class B temperature rise giving a time rating of 15 minutes at 40 degrees C (104 degrees F) at an average load of at least 33% of maximum valve torque. Temperature shall be limited by thermostats embedded in the motor end windings and integrated into its controls. Electrical and mechanical disconnection of the motor shall be possible without draining the lubricant from the actuator gearbox.

j. Protection shall be provided for the motor as follows:

    1) Stall: Motor shall be de-energized within 8 seconds in the event of a stall when attempting to unseat a jammed valve.
    2) Over temperature: Thermostat will cause tripping of the motor. Auto-reset on cooling.
    3) Direction: Phase rotation correction.

k. The actuator gearing shall be totally enclosed in an oil-filled gearcase suitable for operation at any angle. Grease lubrication is not permissible. All drive gearing and components must be of metal construction and incorporate a lost-motion hammerblow feature. The design should be such as to permit the opening of the gearcase for inspection or dissembled without releasing the stem thrust or taking the valve out of service. For 90 degree operating type valves drive gearing shall be self locking to prevent the valve back-driving the actuator.

l. A handwheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to electrical operation automatically by starting the motor. The handwheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection is locked in hand without damage to the drive train. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated. For linear valve types the actuator handwheel drive must be mechanically independent of the motor drive and should be such as to

permit valve operation in a reasonable time with a manual force not exceeding 400N through stroke and 800N for seating/unseating of the valve.

m. The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. The drive bush shall be positioned in a detachable base of the actuator. Thrust bearings shall be sealed for life and the base shall be capable of withstanding five times the rated thrust of the actuator.

n. The actuator shall incorporate local controls for Open, Close and Stop and a Local/Stop/Remote mode selector switch lockable in any one of the following three positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator. The local controls and display shall be rotatable through increments of 90 degrees to suit valve and actuator orientation.

o. Torque and turns limitations to be adjustable as follows:

1) Position setting range: multi-turn: 2.5 to 8,000 turn, with resolution to 7.5 degree of actuator output
2) Position setting range: direct drive part turn actuators: 90 degrees +/- 10 percent, with resolution to 0.1 degrees of actuator output.
3) Torque setting: 40% to 100% rated torque.

p. Position measurement – Absolute positon measurement should be incorporated within actuator. The technology must be capable of reliably measuring position even in a cast of single fault. The design must be simple with the minimum amount of moving part (no more than 5). Technologies such as LEDs or potentiometer for position measurement are considered unreliable and therefore not allowed.

q. Measurement of torque shall be from direct measurement of force at the output of the actuator. Methods of determining torque-using data derived from the motor such as motor speed, current, flux etc are not acceptable.

r. The means of automatic “torque switch-bypass” to inhibit torque off during valve unseating and “latching” to prevent torque switch hammer under maintained or repeated control signals shall be provided. The electrical circuit diagram of the actuator should not vary the valve type remaining identical regardless of whether the valve is open or close on torque or position limit.

s. Remote Valve Positon and Status Indication:

1) Four (4) contacts shall be provided which can be selected to indicate any position of the valve; Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during handwheel operation when all external power to the actuator is isolated. The contacts shall be rated for 5mA to 5A, 120V AC, 30V DC. As an alternative to providing valve position indication any of the four above contacts shall be selectable to signal one of the following:

a) Valve opening, closing or moving
b) Thermostat tripped, lost phase
c) Motor tripped on torque in mid travel, motor stalled

d) Remote selected
e) Actuator being operated by handwheel
f) Actuator fault

2) Provision shall be made in the design for an additional eight contacts having the same functionality.
3) A configurable monitor relay shall be provided as standard, which can be used to indicate either Availability or Fault. The relay should be a spring return type with a Normally Open / Normally Closed contact pre-wired to the terminal bung.
4) The Monitor (availability or fault) relay, being energized from the control transformer will de-energise under any one or more the following conditions:

a) Available Mode: Loss of main or customer 24V DC power supply
b) Fault Mode: Loss of main or customer 24V DC power supply
c) Available Mode: Actuator control selected to local or stop
d) Fault Mode: Motor thermostat tripped
e) Available Mode: Motor thermostat tripped
f) Fault Mode: Actuator internal fault
g) Available Mode: Actuator internal fault

5) Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel and / or torque for remote indication when required. The transmitter will auto range to the set limits

t. Local Position Indication

1) The actuator display shall include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully close in 0.1% increments. Valve closed and open positions shall be indicated by symbols showing valve position in relation to the pipework to ensure that valve status is clearly interpreted. With mains power connected, the display shall be backlit to enhance contrast at all ambient light levels and shall be legible from a distance of at least 5m (16ft).
2) Red, green, and yellow LEDs corresponding to open, closed and intermediate valve positions shall be included on the actuator display when power is switched on. The yellow LED should also be fully programmable for on/off, blinker and fault indication. The digital display shall be maintained and updated during handwheel operation when mains power to the actuator is isolated.
3) The actuator display shall include a fully configurable dot-matrix display element with a minimum pixel resolution of 168 x 132 to display operational, alarm, configuration and graphical datalogger information. The text display shall be selectable between English and other languages such as: Spanish, German, French, and Italian. Provision shall be made to upload a different language without removal of any covers or using specialized tools not provided as standard with the actuator.

4) Datalogger graphical displays should as a minimum be able to display log and trend graphs on the local LCD for the following:

   a) Torque versus Position
   b) Number of Starts versus Position
   c) Number of starts per hour
   d) Dwell Time
   e) Average temperature

5) The main display shall be capable of indicating 4 different home-screens of the following configuration:

   a) Position and status
   b) Position and torque (analogue)
   c) Position and torque (digital)
   d) Position and demand (positioning)

6) Provision shall be made for the addition of an optional environmental cover to protect the display from high levels of UV radiation or abrasive materials.
7) The local controls and display shall be rotatable through increments of 90 degrees to suit valve and actuator orientation.

u. Integral Starter and Transformer

1) The reversing starter, control transformer and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tapping and be adequately rated to provide power for the following functions:

   a) Energizing of the contactor coils.
   b) 24V DC or 110V AC output for remote controls (maximum 5W/VA)
   c) Supply for all the internal electrical circuits.

v. Remote Control Facilities

1) The necessary control, wiring and terminals shall be provided integral to the actuator enclosure. Open and close external interlocks shall be made available to inhibit local and remote valve opening / closing control. It shall be possible to configure the interlocks to be active in remote control only.
2) Remote control signals fed from an internal 24V DC (or 110VAC) supply and/or from an external supply between 20V and 60 VDC or 40V and 120VAC, to be suitable for any one or more of the following methods of control:

   a) Open, Close and Stop control.
   b) Open and Close maintained or “push to run” (inching) control.
   c) Overriding Emergency Shut-down to close (or open) valve from a normally closed or open contact.

d) Two-wire control, energise to close (or open), de-energise to open (or close).

3) Additionally provision shall be made for a separate 'drive enable' input to prevent any unwanted electrical operation.
4) It shall be possible to reverse valve travel without the necessity of stopping the actuator. The motor starter shall be protected from excessive current surges during rapid travel reversal. The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2kV.

w. Monitoring Facilities

1) Facilities shall be provided for monitoring actuator operation and availability as follows:
2) Actuator text display indication of the following status/alarms:

a) Closed Limit, open limit, moving open, moving closed, stopped
b) Torque trip closing, torque trip opening, stalled
c) ESD active, interlock active
d) Thermostat trip, phase lost, 24V supply lost, Local control failure
e) Configuration error, Position sensor failure, Torque sensor failure
f) Battery low, power loss inhibit

3) Integral datalogger to record and store the following operational data:

a) Opening last /average torque against position
b) Closing last /average torque against position
c) Opening motor starts against position
d) Closing motor starts against position
e) Total open/closed operations
f) Maximum recorded opening and closing torque values
g) Event recorder logging operational conditions (valve, control and actuator)

4) The datalogger shall record relevant time and date information for stored data.
5) Datalogger data shall be accessed via non-intrusive *Bluetooth*® communication and data displayed on the local LCD. Sufficient standard intrinsically safe tools shall be provided for downloading datalogger and actuator configuration files from the actuators and subsequent uploading to a PC. The actuator manufacturer shall supply PC software to enable datalogger files to be viewed and analysed.

x. Wiring and Termination

1) Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end. The terminals shall be embedded in a terminal block of high tracking resistance compound.

2) The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal and shall be provided with a minimum of 3 threaded cable entries with provision for an additional 5 extra conduit entries.
3) All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable. A durable terminal identification card showing a plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

    a) Serial number
    b) External voltage values
    c) Wiring diagram number
    d) Terminal layout

4) The code card shall be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

y. Commissioning Kit

1) Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set up and adjustment during valve/actuator testing and site installation commissioning.

z. Performance and Test Certificate

1) Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load, and the following parameters should be recorded.

    a) Current at maximum torque setting
    b) Torque at max. torque setting
    c) Flash test voltage
    d) Actuator output speed or operating time.

2) In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.

aa. Disconnect

1) Provide 16amp, non-metallic, watertight, unfused disconnect (Model number 69-952).
2) Enclosure: Exterior NEMA 3R, Interior Type 1. All with locking quarter-turn latch and key.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturers instructions, roughing-in drawings and details shown on drawings.

B. Control Air Piping:

1. All control air piping shall be copper. Exception: Flexible Tubing may be used for a maximum of two (2) feet at connections to equipment [except for steam control valves] and inside control cabinets.
2. Provide copper tubing with a maximum unsupported length of 3'-0".
3. Pressure Test control air piping at 30 psi for 24 hours. Test fails if more than 5 PSI loss occurs.
4. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.
6. All control tubing at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel.
7. Provide pressure gages on each output device.
8. Paint all exposed control tubing to match existing.

C. 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 rigid conduit to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.

D. 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, descripted 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, descripted 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.

E. All low voltage electrical wiring shall be run as follows:

1. Route electrical wiring in concealed spaces and mechanical rooms whenever possible.
2. Provide 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 surrounding conditions.

F. All devices shall be mounted appropriately for the intended service and location.

1. Wall mounted sensors and thermostats shall be provided with base and covers in occupied areas and mounted 4'-6" above finished floor. 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.
2. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.
3. All control devices shall be tagged and labeled for future identification and servicing of control system.
4. Preheat and mixing air discharge sensors must be of adequate length and installed with capillary tube horizontally traversing face of coil, covering entire coil every 24 inches bottom to top.
5. All field devices must be accessible or access panels must be installed.

G. Install magnehelic pressure gage across each air handling unit filter bank. If the air handling unit has a prefilter and a final filter, two magnehelic pressure gages are required.

H. All meters installed 7 feet above finished floor shall have a remote reader installed in a location satisfactory to the Owner.

3.2 ADJUSTING AND START-UP

A. Start-Up: The start-up, testing, and adjusting of pneumatic and 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.

1. Process Control Network

a. The control boards and enclosures need to be installed in the mechanical rooms.

b. 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.)

2. Cooling System

a. 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.
b. Some balance work can be done alongside the control work as long as areas are mostly complete.

3.3 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.

B. Contractor shall provide as built diagram of network bus routing listing all devices on bus, once wiring is complete prior to scope completion.

END OF SECTION 23 0900

SECTION 23 0990 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

1.2 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. Hydronic systems.
      a. Chilled water and condenser water systems.
   2. 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 one (1) 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. Operate all systems successfully for twenty-four (24) hours minimum.

   5. Lubricate all motors and bearings.
   6. Check fan belt tension.
   7. Check fan rotation.

8. Patch insulation, ductwork and housing, using materials identical to those removed.
9. Seal ducts and piping, and test for and repair leaks.
10. Seal insulation to re-establish integrity of the vapor barrier.
11. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
12. Provide a complete set of as-built drawings prior to the TAB effort.
13. Provide craftsmen of the proper trade to work with the TAB firm to make adjustments and installation changes as required.
14. Change out fan sheaves when and if required by the TAB firm.
15. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
16. 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.

1.3 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.

1.4 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.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION (Not applicable)

END OF SECTION 23 0990

SECTION 23 2113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Chilled-water piping.
   2. Condenser-water piping.
   3. Condensate-drain piping.
   4. Refrigerant vent piping.

1.2 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. Section 23 0100 “Basic Mechanical Requirements,” and Section 23 0500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

C. The following Sections contain requirements that relate to this Section:
   1. Division 23 Section “Basic Mechanical Materials and Methods” for general piping materials and installation requirements, and for labeling and identifying hydronic piping.
   2. Division 23 Section “Hangers and Supports” for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
   3. Division 23 Section “Valves” for general-duty gate, globe, ball, butterfly, and check valves.
   4. Division 23 Section “Meters and Gages” for thermometers, flow meters, and pressure gages.
   5. Division 23 Section “Hydronic Pumps” for pumps, motors, and accessories for hydronic piping.
   6. Division 23 Section “ Control Systems” for temperature-control valves and sensors.

1.3 DEFINITIONS

A. The following definitions apply to the work of this Section. Refer to Division 23 Section “Basic Mechanical Materials and Methods” for additional definitions.
   1. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. PTFE: Polytetrafluoroethylene.
   4. PVC: Polyvinyl chloride.
   5. SWP: Steam working pressure.
   6. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
   7. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.
   8. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 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 (1030 kPa) at 200ºF (93ºC).
2. Condenser-Water Piping: 175 psig (1200 kPa) at 150ºF (66ºC).
3. Condensate-Drain Piping: 150ºF (66ºC).
4. Refrigerant vent piping 175 psig (1200 kPa) at 150ºF (66 C).

1.5 SUBMITTALS

A. Product Data: For each type of the following:
1. Air control devices.
2. Hydronic specialties.
3. Piping material for all systems.

B. Qualification Data: For Installer.

C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

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/dirt separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NFPA 70 – National Electrical Code. Do not route piping directly above electric panelboards and switchboards, or other prohibited locations.

F. Buy-American: All piping shall be furnished from domestic sources (USA).

1.7 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe fitting pressure classes with products specified in related Sections.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manual & Automatic Air Vents:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett; a Xylem Brand.
d. Taco.

2. Simplex Basket Strainer:
a. Eaton.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 “Piping Applications” Article for applications of pipe and fitting materials, including a schedule of which types of piping to use in which application.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B88, Type L (ASTM B88M, Type B).

B. DWV Copper Tubing: ASTM B306, Type DWV.

C. Wrought-Copper Fittings and Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B32, 95-5 tin antimony.

E. Field or shop fabricated fittings are not allowed. Pulled-tees or pipe fittings using “T-Drill” are not allowed.

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; Type E (Electric-resistance welded), Grade B, Schedule 40; unless otherwise indicated in Part 3 “Piping Applications” Article.

B. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M black steel, Grade B, Schedule 40; unless otherwise indicated in Part 3 “Piping Applications” Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 or 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Class 150, 250, or 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Class 125 or 250 as indicated in Part 3 "Piping Applications" Article; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe. All elbows shall be long-radius type.

G. Wrought Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical Joint Fittings and Couplings are not allowed.

2.5 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless Steel Pipe: 304 Schedule 10, ASTM A312, TP304L stainless steel pipe, plain ends.

B. Stainless Steel Fittings: ASTM A403 GR WP304L for welded joints.

C. Stainless Steel Flanges: ASTM A182 GR F304L, ASME B16.5, including bolts, nuts and gaskets.
1. Material Group: 1.1.
2. End Connections: Butt Welding.
3. Facings: Raised face.
4. Type: Slip-on Flange or Weld Neck Flange.
5. Stainless steel stub ends with welded and flanged joints with hot-dipped galvanized backing rings are acceptable at flange connections.

D. Grooved Mechanical Joint Fittings and Couplings are not allowed.

2.6 SPECIALTIES

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joining materials and transition fittings. Those requirements apply to the work of this Section as if fully reproduced herein.

2.7 GENERAL-PURPOSE VALVES

A. Refer to Division 23 Section "Valves" for Check, Ball, and Butterfly Valves, whose requirements apply to the work of this Section as if fully reproduced herein.

B. Refer to Division 23 Section "Control Systems" for Automatic Temperature-Control Valves, Actuators, and Sensors, whose requirements apply to the work of this Section as if fully reproduced herein.

C. Refer to Part 3 "Valve Applications" Article elsewhere within this Section for applications of each type of valve and service.

2.8 AIR CONTROL DEVICES

A. Manual Air Vents: Bronze body, nonferrous internal parts, operated via manual screwdriver or thumbscrew. NPS ½ (DN 15) inlet connection and NPS 1/8 (DN 6) discharge connection. CWP rating shall be 150 psig (1035 kPa) and rated operating temperature shall be 225ºF (107 C).

B. Automatic Air Vents shall be Spirotherm Spirotop Air Relief Valves only.

2.9 HYDRONIC PIPING SPECIALTIES

A. Simplex Basket Strainers,10-inch and Larger:
1. Body: ASTM A126, Class B, high-tensile cast iron cover and ½" NPT bottom stainless steel drain connection. Bolted cover is not allowed. Provide wing nut type system that does not require additional tools to remove. Body shall be in a floor mounted configuration for direct bolting to housekeeping pad.
2. End Connections: Flanged ends.
3. Strainer Screen: 40-mesh startup strainer, and two (2) perforated 5/32 inch 316 stainless-steel strainers. Refer to schedule.
4. CWP Rating: 200 psig (1380 kPa) at 100ºF (38 C).
5. Cover: Swing bolt cover closure with independent hinge and Buna seal. Provide one (1) extra seal.
6. Taps: ¼ inch NPT cover vent taps and inlet/outlet nozzle taps.
7. Drain Plug: NPT 1-1/2 (40 mm), side mounted.
8. Entire unit including but not limited to the inside, outside and cover shall be provided with Manufacturer applied epoxy coating.
9. Basket shall be accessible and removable by hand operation of wing-nut type fasteners. Tools shall not be necessary for basket removal and service.

B. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for Flexible Pipe Connectors, whose requirements apply to the work of this Section as if fully reproduced herein.

PART 3 - EXECUTION

3.1 PIPING SCHEDULE OF APPLICATIONS

A. Chilled-water piping, aboveground, NPS 2½ (DN 65) and larger, shall be Schedule 40 steel pipe; wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

B. Chiller or other chilled-water system drains (blowdown, overflow, etc.): NPS 2 (DN 50) and smaller, shall be Type L (C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

1. Contractor's Option: Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints will be acceptable.

C. Condenser water piping, aboveground, all sizes shall be stainless steel pipe with welded or flanged joints.

D. Condenser water system drains (blowdown, overflow, etc.): NPS 2 (DN 50) and smaller, shall be shall be threaded stainless steel only.

E. Other HVAC-Related Piping Applications:

1. Refrigerant vents (chiller purge vents, chiller refrigerant overpressure relief, etc.):
   a. NPS 2 (DN 50) and smaller, shall be Type L (C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   b. NPS 2½ (DN 65) and larger, shall be Standard Weight steel pipe; wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

3.2 VALVE APPLICATIONS

A. Install valves where indicated on Drawings and where indicated in Division 23 Section "Valves."

B. Install safety valves where required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

C. Install specialty valves where indicated on Drawings.

D. Install drain valves at all low points, and manual air vents at all high points, in mains, risers, branch lines and elsewhere as required for system drainage.

E. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

F. Route automatic air vent discharge in ¼ inch (6.4 mm) poly tubing to floor drain.

3.3 PIPING INSTALLATIONS

A. General: General piping installation is specified in Division 23 Section "Basic Mechanical Materials and Methods," whose requirements apply to the work of this Section as if fully repeated herein.

B. All carbon steel piping shall have an epoxy paint applied to the entire system prior to any liquid entering system and before any insulation is applied to piping system.
   1. Provide Exterior High-Performance Coating by Sherman-Williams Company (The), Benjamin Moore & Co. or PPG Architectural Coatings. Steel Substrates: Epoxy System MPI EXT 5.1F, Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI#101;

Intermediate Coat: Epoxy, high build, low gloss, MPI#108; Topcoat: Epoxy, gloss, MPI#77.

C. Install drains, consisting of a tee fitting, NPS ¾ (DN 20) ball valve, and short NPS ¾ (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. In closed systems, install horizontal piping at a uniform grade of 0.2 percent upward in direction of flow. In open systems (i.e., condenser water), slope horizontal piping 0.2 percent upward back to the open-air device (i.e., cooling tower).

E. For condensate-drain piping, install horizontal piping at a uniform grade of 1.0 percent downward in the direction of flow.

F. Bull-head tees prohibited: Do not use tee fittings in such a way that the flow through the branch leg equals the sum of the flows through two main legs.

G. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

H. Contractor has the option, without further approval from the Engineer, to install piping of larger (but not smaller) nominal diameter from that shown on the Drawings. For example, if 5-inch NPS is shown on the Drawings, contractor may furnish and install 6-inch NPS piping at no additional cost to the Owner; but may NOT furnish and install 4-inch NPS piping if 5-inch is indicated.

I. All elbows shall be long-radius type unless approved by Engineer and Owner.

J. Install valves according to Division 23 Section “Valves.”

K. Install unions in piping NPS 2 (DN 50) and smaller, at final connections of equipment and elsewhere as indicated.

L. Install flanges in piping NPS 2½ (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

M. Identify piping as specified in Division 23 Section “Basic Mechanical Materials and Methods.”

N. Hang, support, and anchor all piping as specified in Division 23 Section “Hangers and Supports.”

O. Connect copper branch lines to steel or iron mains as follows: Install steel branch pipe off main with black iron nipple, black iron piping as required to locate valve in an accessible location and then connected to bronze ball valve. Connect bronze ball valve to copper piping with threaded copper male adaptor, which is then soldered to the copper branch line.

P. Install branch connections to the top of the main pipe.

Q. Changes of direction, branches, tees, etc. shall be accomplished with the appropriate factory or foundry fitting meeting the requirements of these specifications. Mechanically-formed extruded tee outlets or field-fabricated tee branches and/or elbows are not acceptable.

3.4 PIPE JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joint construction requirements for soldered joints in copper tubing; threaded, welded, and flanged joints in steel piping

B. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.

1. Apply one coat of self-priming, rust-inhibitor paint around the entire circumference of each welded pipe joint; regardless of whether or not the piping is specified to be painted. Paint may be brush-applied, roller-applied, or spray-applied at contractor's option.

3.5 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 ball valve at all locations were a manual air vent is installed as indicated on Drawings.

C. Install automatic air vents where indicated on Drawings.

D. Install simplex basket strainers at location indicated on Drawings. Install line size shutoff valves on inlet, outlet and bypass around strainer.
1. Install strainer fittings that are shipped loose.
2. Support strainer from floor on concrete housekeeping pad.
3. Coordinate installation of strainer to allow removal of strainer out the top of unit.

3.6 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. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on 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. Do not pressure test with air.
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 percent of specified minimum

yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. Minimum duration of test shall be four (4) hours. During the final hour of the hydrostatic test, 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 chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.7 CLEANING AND ADJUSTING

A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 23 2113

SECTION 23 2123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Split coupled vertical in-line centrifugal pumps.

1.2 RELATED DOCUMENTS

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

B. Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

C. The following Sections contain requirements that relate to this Section:

   1. Division 23 Section “Meters and Gages” for thermometers and pressure gages, connector plugs, and devices.
   2. Division 23 Section “Motors” for pump motors.
   3. Division 23 Section “Control Systems” for interlock wiring between pumps, and between pumps and field-installed control devices.
   4. Division 26 Sections for power-supply wiring, field-installed disconnects, required electrical devices, and motor controllers.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. HI: Hydraulic Institute.

1.4 SUBMITTALS

A. General: Follow the procedures specified in Division 01 Section “Special Conditions.”

B. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.

D. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals specified in Division 01.

E. Certified Performance: Provide performance report for all pumps certifying performance within Acceptance Level 2B, as defined by Hydraulic Institute HI 14.6. Pumps shall not be released for shipment until after Engineer and Owner approval of certified reports issued.

F. Provide motor submittal with pump submittal. Any pump submittal that does not include the required motor data as outlined in specification section 230513 Motors will be rejected without further review.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific "basis of design" system indicated. Refer to Division 23 Section "Basic Mechanical Requirements" for use of products other than the "basis of design."

C. Published pump performance (flow and head delivered) shall be determined by factory-testing per ANSI/HI 14.6 *Rotodynamic Pumps for Hydraulic Performance Acceptance Tests*.

D. Regulatory Requirements: Comply with provisions of the following:

1. ASME B31.9 "Building Services Piping" for piping materials and installation.
2. Hydraulic Institute's "Standards for Centrifugal, Rotary & Reciprocating Pumps" for pump design, manufacture, testing, and installation.
3. UL 778 "Standard for Motor Operated Water Pumps" for construction requirements. Include UL listing and labeling.
4. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labeling.
5. NFPA 70 "National Electrical Code" for electrical components and installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Extended Storage Longer than 5 Days: Dry internal parts with hot air or vacuum-producing device. Coat internal parts with light oil, kerosene, or antifreeze after drying. Dismantle bearings and couplings; dry; coat with acid-free, heavy oil; tag; and store in dry location.

D. Retain protective covers for flanges and protective coatings during storage. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 EXTRA MATERIALS

A. Furnish one extra mechanical seal for each pump that matches products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 PUMPS, GENERAL

A. Manufacturer: Subject to compliance with requirements, provide products by:
1. Armstrong Pumps Inc.

B. Motors: NEMA MG 1, general purpose, continuous duty, Design B, except Design C where required for high starting torque. Furnish single-speed motors, with type of enclosures and electrical characteristics indicated. Include grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve. Motors shall be high efficiency, premium quality, secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Motors," whose requirements apply to the work of this Section as if fully reproduced herein.
1. Vertical In-Line Centrifugal Pumps shall be provide inverter-duty motors where variable speed drives are indicated.
2. Vertical In-Line Centrifugal Pumps shall be provided with Aegis SGR shaft grounding rings on motors.
3. Motor shall match existing tower pump (TP-1).

C. Factory Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.

D. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

E. Operating Speed: Do not exceed 1800 rpm unless expressly scheduled on the Drawings.

F. Pump shall meet and/or exceed scheduled minimum efficiency. Pumps submitted that do not meet minimum efficiency will be rejected without further review.

2.2 VERTICAL IN-LINE CENTRIFUGAL PUMPS

A. Vertical In-line Pump: Factory-assembled and -tested, centrifugal, overhung-impeller, , inline pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Provide pump with characteristics which provide rising heads to shut-off. Refer to pump schedule for pump flows and heads and motor speed, enclosure, efficiency and power requirements and other system conditions. Pump shall be split-coupled type vertical in-inline units, with rigid spacer type coupling.

B. Separately-coupled; and shaft-vertical.

C. Casing: Cast iron with ANSI-125/PN16 flanges for minimum working pressure to 175 psig (12 bar) and a continuous water temperature of 150ºF. Suction and discharge connections shall be flanged and the same size and shall be tapped for seal flush and gauge connections.

D. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Provide full size impeller. Trimming of impeller shall be done during testing and balancing of system.

E. Pump Shaft: Stainless steel, with bronze or copper-alloy shaft sleeve.

F. Shaft Coupling: Rigid spacer type of high tensile aluminum alloy. Coupling to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.

G. Mechanical Seal: Shall be stainless steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plate. Provide factory installed flush line with manual vent.

H. All split coupled pumps shall be provided with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication.

I. Pump Bearings: Permanently lubricated ball bearings.

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig (1204-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Pump Base Support: Provide optional base support for all vertical in-line pumps. Pump shall be supported with stanchion plates.

C. Flow Straightener: Provide flow straightener, Vane Flex Flange, manufactured by The Metraflex Company, Chicago, IL or approved equal.
1. End fittings shall be carbon steel plate flange with 150 lbs drilling.
   a. Flange thickness: 1-inch minimum.
2. Vanes shall be 304 stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation. Examine foundations and/or inertia bases for suitable conditions where pumps are to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Basic Mechanical Materials and Methods."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For supported equipment, install stainless steel anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

A. Install pumps according to manufacturer's written installation and alignment instructions. Comply with HI 1.4.

B. Install pumps in locations indicated and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Independently support vertical in-line pumps install stands furnished with pump by pump manufacturer so weight of piping is not supported by pumps and weight of pumps is not supported by piping. Pump shall be supported by stanchion plates.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Refer to Drawings. Install one pressure gage for each pump. Connect the suction and discharge of each pump at the tappings provided. Install isolation ball valves in each line upstream of pressure gage.

F. Install electrical connections for power, controls, and devices.

G. Connect wiring and ground equipment according to Division 26 Sections.

3.5 STARTUP SERVICE

A. Final Checks Before Startup: Engage a factory-authorized service representative to perform startup service and the following preventive maintenance operations and checks before startup:

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Lubricate bearings.
5. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's recommendations.
6. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
7. Check that pumps are free to rotate by hand. Pumps for handling hot liquids shall be free to rotate with pump hot and cold. Do not operate pump if it is bound or even drags slightly until cause of trouble is determined and corrected.
8. Check that pump controls are correct for required application.
9. Starting procedure for pumps with shutoff power not exceeding safe motor power.
10. Prime pumps, opening suction valve, closing drains, and preparing pumps for operation.
11. Start motors.
12. Open discharge valves slowly.
13. Check general mechanical operation of pumps and motors.
14. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except that discharge valves are opened sometime before motors are started.

B. Refer to Division 23 Section “Testing, Adjusting, and Balancing” for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 TRIM IMPELLER

A. Testing, Adjusting and Balancing is the work of Division 23 Section “Testing, Adjusting, and Balancing.” After initial testing and balancing, the work of this Section shall include impeller trim. Remove, trim, and reinstall the impeller of all pumps, to match specified performance. Impeller trim shall be performed in a qualified shop acceptable to the pump supplier. Trim impeller to exact diameter as determined under Division 23 Section “Testing, Adjusting, and Balancing” matching the desired performance in consultation with the pump curve.
   1. Exception: Impeller trim is not required for pumps whose speed is controlled by a variable frequency drive.
   2. Exception: Impeller trim is not required for pumps whose motor is 10 HP or smaller.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01.

END OF SECTION 23 2123

SECTION 23 6416 - PACKAGED LIQUID-COOLED CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, electric-motor-driven liquid-cooled chillers with the following features:

1. Centrifugal compressor.
2. Water-cooled condenser.
3. Compressor Motor Starter: Variable Frequency Drive (VFD).
4. Microprocessor-based controls complying with ASHRAE 135.

B. Related Sections include Division 23 Section “Control Systems” for refrigerant monitors, alarms, and ventilation equipment interlocks.

1.2 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. Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

C. Related Sections include Division 23 Section “Control Systems” for refrigerant monitors, alarms, and ventilation equipment interlocks.

1.3 REFERENCED STANDARDS

A. AHRI Compliance: Performance shall be rated in accordance with AHRI Standard 550/590-2015 *Water Chilling Packages Using the Vapor Compression Cycle* including published addenda. Sound Pressure Level shall be rated in accordance with ANSI/AHRI Standard 575-2008 *Method of Measuring Machinery Sound within an Equipment Space*.

B. ASHRAE Compliance: Conform to ANSI/ASHRAE Standard 15-2019 *Safety Standard for Refrigeration Systems* for chiller design, construction, and leak testing. Conform to ANSI/ASHRAE Standard 34-2019 *Designation and Safety Classification of Refrigerants* for refrigerant specifications.

C. ASME Compliance: Comply with ASME *Boiler and Pressure Vessel Code*, Section VIII, “Pressure Vessels,” Division 1, “Basic Coverage” for constructing and testing cooler and condenser pressure vessels. Any pressure vessel whose refrigerant-side normal design operating pressure exceeds 15 psig shall include an ASME “U” stamp and nameplate certifying compliance as an unfired pressure vessel.

D. Comply with NFPA 70-2017 *National Electrical Code* pertaining to electrical power and control wiring.

E. Comply with UL 1995 *Heating and Cooling Equipment* 4th edition.

F. Comply with ANSI/UL 508 for variable frequency controller.

G. UL Listing: Motor controller shall be listed by Underwriters Laboratories and classified as suitable for the installed use and environmental conditions.

H. Energy Compliance: No chiller will be accepted which does not meet Table C-3 values in ASHRAE Standard 189.1-2014 *The Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings*, or as scheduled on the Drawings, whichever is greater.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Owner has pre-purchased the liquid packaged chiller for this project. Coordinate with Owner's Representative all delivery, storage and handling requirements. Coordinate delivery date to site with Manufacturer.

B. Any damaged chiller will be rejected upon arrival.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations. Final chiller locations indicated on Drawings are approximate, unless dimensioned. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine proposed route of moving chillers into place and verify that it is free of interferences.

C. Locate chiller in general position indicated in relation to other work. Position chiller with sufficient clearance for normal service and maintenance, including clearance for cleaning and replacement of tubes, and clearance for motor replacement.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 LIQUID-COOLED CHILLER INSTALLATION

A. Except as otherwise indicated, install chiller work including components and controls required for chiller operation in accordance with chiller manufacturer's instructions, and with recognized industry practices, to ensure that chiller equipment complies with requirements and serves intended purposes.

B. Install and anchor chillers plumb and level.

C. Install chillers on concrete base. Concrete base is specified in Division 23 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.

D. Concrete Bases: Anchor chiller mounting frame to concrete base.
   1. Typical at each chiller: Provide 9'-0" x 1'-6"x6" concrete pad at each end centered under chiller bearing feet (two (2) per unit). Coordinate with chiller manufacturer. Provide (4) #6 long way in top of pad (1-inch clear) with hook each end, turned down and embedded 4-inch into existing slab with Hilti Hithy200 adhesive. At contact surfaces between pads and existing slab, sandblast existing concrete and coat with Sikadur 32 Hi-Mod bonding. Follow Sika instructions. At each foot of unit shall sit on elastomeric isolator pad (four (4) per unit) attached to new concrete base with anchor bolts. Refer to specification (typical).
   2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   3. Install anchor bolts to elevations required for proper attachment to supported equipment.
   4. Coordinate size and orientation of chiller housekeeping pad with actual dimensions of chiller furnished; housekeeping pad shall be 6" larger than chiller base on all sides.
   5. Cast-in-place concrete materials and placement requirements are specified in Division 03.

E. Vibration Isolation: Mount chiller on vibration isolation as specified in Division 23 Section "Mechanical Vibration Isolation."

F. Maintain manufacturer's recommended clearances for service and maintenance.

G. Charge chiller with refrigerant, if not factory charged, in the quantity recommended by chiller manufacturer. Pressure-test chiller refrigerant system for leakage in manner recommended by manufacturer. Bleed-out noncondensible gases charged with refrigerant.

H. Install separate devices and auxiliary piping furnished by manufacturer but shipped loose.

3.3 CONNECTIONS

A. Chilled- and condenser-water piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install flanged connections at chillers. Install piping adjacent to chillers to allow service and maintenance; with all piping installed outside the zone needed for heat exchanger tube pull except for the final connection to the water boxes.

C. Evaporator Connections: Refer to Drawings for all components required to be installed.

D. Condenser Connections: Refer to Drawings for all components required to be installed.

E. Connect each drain connection with a ball valve, hose-end thread connection, and threaded screw-on pipe cap, full size of connection.

F. Field-pipe the refrigerant pressure relief device outlet to discharge to the existing vent piping shown on Drawings.

G. Coordinate power wiring with party responsible for Division 26 work, and furnish and install any wiring to auxiliaries or control panels as required and in accordance with Division 26.

1. Install controls and control wiring as required, in accordance with manufacturer's written instructions.
2. Install and interlock flow switches with chiller controls in accordance with manufacturer's instructions.
3. Connect wiring and ground equipment according to Division 26 Sections.
4. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 CLEANING AND TOUCH-UP

A. Clean units using materials and methods recommended by manufacturer.

B. Clean finishes to remove dust and dirt. Touch up scratches on unfinished surfaces to restore corrosion resistance. Touch up scratches on finished surfaces to restore finish.

C. Repair or reinsulate any factory-insulated surfaces that were damaged during shipping, handling, or installation.

3.5 MANUFACTURER'S FIELD STARTUP SERVICES

A. Startup Services are provided by Manufacturer and are explained in pre-purchase packaged liquid chiller specifications. Coordinate with Owner's Representative five (5) working days in advance for chiller start-up to be scheduled.

3.6 COMPLETION AND CLOSEOUT

A. Do not place chiller in sustained operation prior to initial balancing of mechanical systems affected by chiller operation.

B. Cooperate with other trades and installers of other work during testing, adjusting, balancing and start-up of mechanical systems. Testing, adjusting, and balancing is specified in Division 23 Section “Testing, Adjusting and Balancing.”

END OF SECTION 236416

SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section specifies the basic requirements for electrical installations and includes requirements common to all sections of Division 26. It expands and supplements the requirements specified in sections of Division 00.

B. Drawings and general provisions of the Contract, including general and supplementary conditions and specification sections Divisions 00 through 02, apply to this Section.

C. Codes and Standards: All equipment, material and installations shall comply with applicable codes, standards, and installation practices. Comply with the requirements of the applicable local building codes, the applicable NEC, all local rules and regulations including those of the fire authorities. Comply with all applicable NFPA standards. All material and equipment shall be listed by the Underwriters Laboratories (UL) standard that is applicable for the specific purpose of the material and equipment. The National Electrical Code, National Electrical Manufacturer's Association (NEMA) Standards, and applicable ANSI and IEEE standards shall apply to the pertinent materials, equipment, and installation practices. Testing shall be in accordance with the applicable International Electrical Testing Association (NETA) standards.

1. These specifications include references to the 2014 edition of the NFPA 70 "National Electrical Code." Where a different edition of the NEC has been adopted by the local Authority Having Jurisdiction, the references associated with that edition of the Code shall be applicable.

1.2 SUMMARY OF WORK

A. The word "furnish" means supply for use, the word "install" means install in its proper location and connect up complete and ready for operation, and the word "provide" means to furnish and install.

B. Provide all new materials as indicated on the drawings and specifications and all items required to make the electrical system complete and in working order.

C. System descriptions included in scope of work are as follows:

1. Electrical power systems, including luminaires, distribution equipment, motors, wiring devices, etc.
2. Electrical power distribution service from the Utility Company including metering.
3. Grounding system.
4. Fire alarm system.
5. Power and communications for temperature control system.
6. Wiring of equipment furnished by the Owner or other Divisions.
7. Selective demolition work and modification of existing systems and equipment.
8. Low voltage systems as described in Division 28.

D. Work not included:

1. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) shall be by other Divisions.

1.3 WORK SEQUENCE

A. All work that produces excessive noise or interference with normal building operations shall be coordinated and scheduled with the Owner. Such work may require scheduling of work after occupied hours or weekends. The Owner reserves the right to determine when such work is conducted.

1.4 QUALITY ASSURANCE

A. Responsibility Prior to Submitting Pricing or Bid Data:

1. Thoroughly review the contract documents and specifications and visit the site prior to issuing bid. Resolve all reported deficiencies with the Engineer prior to awarding any subcontracts, ordering material, or starting any work.

B. Qualifications:

1. Only products of specified manufacturers, or approved equals as determined by the Engineer, are acceptable.
2. Employ only workmen who are skilled in their trades.

C. Compliance with Codes, Laws, and Ordinances:

1. Conform to all requirements of the state, city and local codes, laws and ordinances and other regulations having jurisdiction over this installation.
2. If there are any discrepancies between the codes and regulations and these specifications, the Engineer shall determine the method or equipment to be used.
3. Inform the Engineer in writing, requesting a clarification at the time of the bidding, if any parts of the drawings or specifications are found not to comply with the codes or regulations. Submit a separate price to make the system comply if there is insufficient time for this procedure.
4. Inform the Engineer in writing requesting a clarification if there is any discrepancy between a manufacturer’s recommendation and these specifications.
5. Follow the current issue of NFPA 70 “National Electrical Code” if there are no local codes having jurisdiction.

D. Examination of Drawings:

1. The drawings for the indicated work are diagrammatic, intended to convey the scope of the electrical work and to indicate the general arrangements and locations of equipment, wiring devices, etc., and the approximate sizes of equipment. Field verification of dimensions on plans is required. The actual conditions, including heights, lengths and orientation shall be the basis of the work.
2. The architectural, structural, mechanical and electrical drawings and specifications shall be considered as mutually explanatory and complementary. Any electrical work called for by one and not by the other shall be performed as though required by all. All sections and subsections of the Electrical work shall be governed by and subject to the general and

supplementary conditions. Report any discrepancies in or between the drawings and specifications, or between the drawings and actual field conditions to the Engineer in sufficient time to issue an addendum for clarification.

3. Determine the exact locations for equipment and rough-ins, and the exact routing of raceways.
4. Do not scale drawings to determine equipment and system locations.
5. Not all required components are shown on the documents, including junction boxes, pull boxes, conduit fittings, etc. Provide all components required for proper installation of the work.
6. Any item either shown on the drawings or called for in the specifications shall be included in this contract.
7. Determine quantities and quality of material and equipment required from the documents. Provide the more expensive or higher quality amount where discrepancies arise among drawings, schedules or specifications.

E. Electronic Media and Files:

1. Electronic media files of the contract drawings in AutoCAD or PDF format and copies of the specifications in PDF format may be requested.
2. Complete and return a signed "Electronic File Transmittal" form provided by Ross & Baruzzini upon request for electronic media,
3. Obtain approval from the appropriate Design Professional for use of their part of the documents if the information requested includes information prepared by other than Ross & Baruzzini.
4. The electronic contract documents may be used for preparation of shop drawings and record drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by Ross & Baruzzini for bidding purposes may not be used directly for raceway layout drawings or coordination drawings.
6. The use of these documents does not allow relief from the responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project with no guarantee by Ross & Baruzzini as to the accuracy or correctness of the information provided. Ross & Baruzzini accepts no responsibility or liability for the use of the provided information.

1.5 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Coordinate equipment rough-in requirements with Divisions 02 through 28.

1.6 SUBMITTAL REVIEW RESPONSIBILITIES

A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 02. Un-requested submittals will not be processed or reviewed and will be returned to the submitter. Refer to "Submittal Register" for all required submissions of each specification section. All required submissions of that

specification section are to be submitted for review in one all-inclusive submission. Any deviation from specified items is considered a substitution.

1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not provide relief from full compliance with the contract documents.
2. Any deviation from specified items is considered a substitution. A formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 02, if the use of other than specified items is being proposed. Where not defined in Division 02, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. The submitter must pay the engineer for review of substitution requests. Charges for this substitution review will be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

B. Definitions:

1. Product Data: Pre-printed manufacturer's data.
2. Shop Drawings: Drawings made specifically for the manufacture of a particular piece of equipment to be used on this project.
3. Operation and Maintenance Data: Information containing instructions on the proper operation, maintenance and repair of the equipment, complete with written text, diagrams, photos, exploded views and parts lists.
   Record Documents: Information indicating the actual installed conditions of the project on Mylar, electronic media, photographs or typed paper. Photographs are not allowed as a substitute for correcting the construction documents; the photographs are for the Owner's future reference. Submit type, quantities and on media specified where indicated to be submitted.

C. Where more than one model is shown on a manufacturer's sheet, clearly indicate exactly which item and which data is relevant to the work.

D. Where the manufacturer lists multiple part numbers or options on a single data sheet, the part number and options to be used shall be clearly set apart from other part numbers shown on that sheet.

E. Ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review. The Contractor's approval stamp is required on all submittals before submittal to the Engineer. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Clearly mark all deviations from the contract documents on all submittals. The item shall be required to meet all drawing and specification requirements if deviations are not clearly marked.

1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal. Partial or incomplete submissions will be rejected.
2. The Engineer shall not be responsible for informing the submitter on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.

3. The Engineer shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.
4. The Engineer shall review each submittal no more than two times and return to the submitter with the appropriate disposition.
5. If the Engineer is required to review a submittal a second time, it will be limited to review of the changed information, which must clearly be highlighted by the submitter. The submittal will be returned to the submitter with the appropriate disposition.
6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the submitter. Charges for this additional submittal review will be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

F. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 02. Ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. Submit only the data requested under the submittals portion of each specification section. FAX or photo copies are not allowed as submittals for operating and maintenance manuals. The Engineer will review the submittal for the Operation and Maintenance Manual one time and return to the submitter with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the submitter. Charges for this additional submittal review will be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
2. Submittals for the Operation and Maintenance Manual must be original documentation.
3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.

G. Coordination Drawings: Prepare and submit Coordination Drawings as further described herein and as indicated in the Special Conditions. Provide the Engineer with one copy of all coordination drawings supplied to the Owner when required in this specification. Coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

H. Refer to Division 02 and each individual Division 23 Section for additional submittal requirements.

1.7 BUY AMERICAN ACT

A. Use only construction materials and components in performing under these specifications in accordance with the Buy American Act (41 USC 10a-10d), or submit waivers for same as permitted thereunder.

B. Each material or component must be manufactured in the United States and the cost of the domestic sub-components must exceed 50% of the cost of all the components unless one or more exceptions apply under the Buy American Act.

C. Comply by either certifying that the materials purchased for the project meet the criteria or apply for a waiver. Document compliance by one of these methods as part of each product's shop drawing submittal.

1.8 PRODUCT OPTIONS AND MATERIAL SUBSTITUTIONS

A. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 26, 27 or 28 section, do not assume that the selection of materials is an option. Refer to "Part 3 – Execution" subsection of that same specification section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of conductors, and Part 3 will describe which type and grade of conductors to use for a given application.

B. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work except as otherwise indicated.

C. Provide products which are compatible within systems and other connected items.

D. Substitutions: Products other than those specified must be submitted, approved and secured in writing from the Engineer via Addendum. If requested, a sample of the proposed substitution must be submitted to the Engineer for evaluation. This sample shall be supplied at no cost to the Engineer, and will be returned to the submitter, at the submitter's expense at the end of the evaluation period.

E. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis of design and establishes the quality required.

F. Any material, article or equipment of other unnamed manufactures which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Engineer via Addendum. Assume all costs incurred as a result of using the offered material, article or equipment, including the part of other Divisions whose work is affected.

G. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. Assume all costs incurred as a result of using the offered material or equipment on his part or on the part of other Divisions whose work is affected.

H. All material substitutions requested after the final Addendum must be listed as voluntary changes on the bid form.

1.9 PRODUCT, DELIVERY, STORAGE, HANDLING AND MAINTENANCE

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage and handling. Protect stored equipment and materials from damage.

B. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed

for the smooth and efficient flow of installations. Review the site prior to bid for path locations and any required building modifications to allow movement of equipment.

C. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.

D. Keep all materials clean, dry and free from damaging environments.

1.10 MISCELLANEOUS MATERIALS

A. Miscellaneous Materials Include:

1. Miscellaneous metals for support of electrical materials and equipment.
2. Wood grounds, nailers, blocking, fasteners and anchorage for support of electrical materials and equipment.
3. Concrete bases for equipment.
4. Sealers for sealing around electrical materials and equipment; and for sealing penetrations in floors and walls.

1.11 WARRANTIES

A. Refer to the Division 02 “Closeout Procedures” for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties specified in Divisions 26, 27 and 28 into a separated set of vinyl covered, three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Warranty requires correction of all work found to be defective or nonconforming to the Contract Documents, without cost to the Owner. Bear all costs associated with corrective measures and damage due to defects or nonconformance with the Contract Documents, excluding repairs required as a result of improper maintenance or operation, or normal wear and tear as determined by the Engineer.

PART 2 - PRODUCTS

2.1 MISCELLANEOUS LUMBER

A. All lumber shall be fire-treated.

B. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative-treated in accordance with AWPB LP-2, and kiln-dried to a moisture content of not more than 19 percent.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time and recommended for interior and exterior applications.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounted items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right-of-Way: Give to piping systems installed at a required slope.

F. Jobsite Safety: The Contractor is the sole entity responsible for jobsite safety.

3.2 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of sealants and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Coordinate equipment rough-in requirements with Divisions 02 through 28.

3.4 ELECTRICAL INSTALLATIONS

A. Coordinate electrical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

D. 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.

E. 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.

F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials and equipment to conform to project requirements and 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. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.

H. Systems, materials and equipment which will be exposed in finished areas shall be installed level and plumb, parallel and perpendicular to other building systems and components.

I. Install electrical services and overhead equipment to provide the maximum headroom possible where mounting heights are not detailed or dimensioned.

J. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. Maintain code clearances in front of and about all electrical equipment. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.

K. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems and structural components.

L. Include in the Work all labor, materials, equipment, services, apparatus and drawings (in addition to the Contract Documents) as required to complete the intended Work.

M. Control and interlock wiring shall be installed in a separate raceway and shall not be installed in the same raceway as power conductors.

N. Only new, clean and perfect equipment, apparatus, materials and supplies of latest design and manufacture shall be incorporated in the Work in order to assure an electrical system of high quality.

O. The Work required in order to obtain utility services such as telephone and electric, is delineated in these specifications and on the drawings. Unless otherwise noted, construction or connection charges (except for temporary power) by those companies shall be paid by the Owner.

P. Determine electrical utility elevations prior to installation and coordinate with other trades. Installation priorities at a minimum shall be as follows:

1. Luminaires.

2. Gravity flow piping, including steam and condensate.
3. Sheet metal.
4. Other piping.
5. Conduits and wireway.

3.5 CONNECTIONS TO EQUIPMENT AND APPLIANCES

A. In many instances the drawings show an outlet box and power supply for specific equipment, be it Owner- or Contractor-furnished. It is to be understood, unless otherwise noted, that the Work includes a connection from the box to the equipment or appliance. Verify circuit conductor quantities and sizes and overcurrent device number of poles and rating as well as any special grounding requirements, for all Owner-furnished equipment and adjust the required work accordingly.

B. Owner Furnished Equipment:

1. Install and connect Owner-supplied items electrical items indicated on Architectural Equipment Plans and Schedules even if not shown on the electrical plans. Connect all Owner-supplied items requiring electrical connections, whether or not shown on the electrical plans. Make all electrical system connections required for fully functional units.

2. The Owner will supply manufacturer’s installation data for new equipment purchased by owner for this project.
3. Repair all damage to Owner-furnished equipment caused during installation, to the satisfaction of the Owner.

3.6 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 02 Section "Execution." In addition to the requirements specified in Division 02, the following requirements apply:

1. Perform cutting, fitting and patching of 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. 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.

2. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

   a. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
   b. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.7 CONCRETE BASES

A. Provide concrete bases for all floor-mounted electrical equipment.

B. Form concrete equipment bases using nominal 2 inch by 4 inch framing lumber (use larger framing if larger pads, such as for engine-generators are required) with form release compounds. Locate as indicated and construct 4 inches larger in both directions than supported unit. Except where otherwise indicated, pour bases 4 inches higher than surrounding slab. Chamfer top edges and corners.

C. Include all concrete materials and workmanship required for the electrical work. Materials and workmanship shall conform to the applicable standards of the Portland cement Association. Reinforce with 6-inch x 6-inch, W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.

D. Where the base is less than 12-inches from a wall, the base shall be carried to the wall to prevent a “dirt-trap.”

E. Place concrete and allow to cure before installation of equipment.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit and place wood grounds, nailers, blocking and anchorage accurately in location, alignment and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 APPLICATION OF SEALERS

A. General: Comply with sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.11 INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Contractor shall X-ray concrete slabs and walls prior to core drilling to avoid damage to utilities or reinforced steel.

B. Seal space outside of conduits with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

2. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated.

3.12 FIRESTOPPING

A. Apply rated firestopping sealants at all penetrations of fire and smoke walls; at all penetrations of floors and at other locations as noted on the drawings or where required by Code. Consider walls that are common to different abutting buildings, to different additions to buildings, and to fire and smoke separations within buildings as requiring firestopping sealant. Refer to architectural drawings. For existing buildings where fire separations are not noted on any drawings, use reasonable logic as to which separations are fire-rated. When in doubt, consult with Engineer or Architect.

B. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.13 PAINTING

A. Paint all electrical equipment that is marred or damaged prior to the Owner’s acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.

3.14 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner’s final acceptance of the project.

B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc., from all equipment.

C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

D. Refer to the Division 02 Section "Closeout Procedures" for general requirements for final cleaning.

3.15 SPECIAL REQUIREMENTS

A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.

B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement and orientation of equipment with the Owner's representative prior to setting equipment.

C. Include removal and reinstallation of equipment and devices if they were installed without regard to coordination of access requirements and without previous confirmation with the Owner's representative.

3.16 SYSTEM COMMISSIONING

A. The electrical systems shall be complete and operating. Include system start-up, testing, balancing and satisfactory system performance. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.

B. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls and alarms.

1. Utilize only skilled technicians to ensure that all systems perform properly. Reimburse the Owner on a time and materials basis for services rendered at the Engineer's standard hourly rates in effect when the services are requested if the Engineer is requested to visit the job site for troubleshooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation, workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design. Pay the Owner for services required that are project-, installation- or workmanship-related. Payment is due within 30 days after services are rendered.

3.17 FIELD QUALITY CONTROL

A. General:

1. All required equipment and systems tests shall be made during and post-Construction as required.
2. All required testing instruments, meters, etc., shall be provided.
3. Technicians operating testing equipment shall be trained in testing procedures.
4. Testing shall confirm that equipment and systems provided by the Contractor have been installed properly.
5. Unsatisfactory test results shall result in revisions or replacement of equipment or settings as required to provide a system capable of meeting test requirements. Tests shall be repeated or additional tests made as necessary to confirm system capability as required by the Owner, Engineer or Authority Having Jurisdiction.

3.18 EXCAVATION, FILL, BACKFILL, COMPACTION, AND RESTORATION

A. General:

1. Prior to any excavation or digging, verify all underground utility locations. Contact all location services with sufficient time allowance for completion of utility location documentation.

2. Unless noted otherwise provide all excavation, fill, backfill, compaction and restoration required for the scope of work.

B. Excavation:

1. Excavations shall be made to proper dimensions and to accurate, solidate and undisturbed earth.
2. Provide all excavations that exceed the depth requirements with concrete of the same characteristics for foundations or compacted sand gravel fill. The type of fill shall be determined by the Engineer.
3. Do not damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
4. Protect all excavations to prevent cave-ins and risk to workmen.
5. Saw-cut pavement or concrete surfaces where required for excavation with clean edges.
6. Notify Engineer if bearing soil is not found to be adequate and halt excavation operation until given direction from the Architect or Engineer.
7. Confirm the soil conditions at their own cost. Excavations shall be conducted as required in the documents.
8. A compacted bed of sand and gravel (minimum of 3 inches deep) shall be provided where trench is excavated in rock.

C. Dewatering:

1. All trenches and pits shall be kept free of accumulation of water. Provide all required equipment.

D. Underground Obstructions:

1. The electrical drawings do not necessarily show all underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of the construction. Review the documents of all Divisions to determine other obstructions. Take applicable precautions in making installations near underground obstructions.
2. If objects not indicated on the drawings are encountered, remove, relocate or perform extra work as indicated by the Engineer.

E. Fill and Backfilling:

1. Furnish all necessary sand and material for backfilling. Waste material and garbage are not acceptable materials.
2. Remove excess excavated earth as directed.
3. Backfill materials shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to remain in un-backfilled trenches.
4. All trenches and excavations shall be backfilled immediately after completion of conduit installation or forms removal unless otherwise noted.
5. Areas around piers, independent foundations or structures shall have backfilled on all sides to prevent displacement. Fill and backfill shall be spread uniformly.
6. All conduits that are not concrete encased shall be provided with a bed of a minimum of 3 inches depth of compacted sand. Backfill shall be provided with compacted layers above the conduits.

7. Provide sand backfill to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6 inches above the top of the conduit.
8. Backfill shall be made in layers of sand not exceeding 6 inches in depth.
9. Protect surface to prevent loads from the top of the surface for a minimum of 48 hours after backfilling operation.

F. Surface Restoration:

1. Areas shall be restored to the original condition, including areas that are landscaped. Replace all planting and landscaping features removed or damaged to its original condition. At least 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement and other surfaces removed or damaged shall be replaced to original condition. Broken edges shall be saw cut and repaired as directed by Architect or Engineer.

3.19 OPERATION AND MAINTENANCE DATA

A. Refer to the Division 02 Section: “Closeout Procedures” for procedures and requirements for preparation and submittal of maintenance manuals.

B. In addition to the information required by Division 02 for Maintenance Data, include the following information:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions, regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

C. Submit three (3) properly indexed and bound copies in “D” ring style notebooks, of the Operations and Maintenance Instructions to the Architect or Engineer. Make all corrections or additions required.

D. Operation and Maintenance Instructions shall include:

1. Notebooks shall be heavy duty locking three-ring binders, black in color, and incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. “Peel and stick” labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. Size notebooks a minimum of 1/2 inch thicker than the material for future inserts. Label the spine and front cover of each notebook. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other forms of binding will be acceptable.

2. Prepare binder covers (front and spine) with printed title "Operation and Maintenance Instructions," title of project, and subject matter of binder when multiple binders are required.
3. Title page with project title, Architect, Engineer, Contractor, and Subcontractor with addresses, telephone numbers, and contacts.
4. Table of Contents describing all index tabs.
5. Listing of all Subcontractors and major equipment suppliers with addresses, telephone numbers and contacts.
6. Index tabs dividing information by specification section, major equipment, or systems. All tab titles shall be clearly printed under reinforced plastic tabs. Label all equipment to match the identification in the construction documents.
7. Copies of warranties.
8. Copies of all final approved shop drawings and submittals. Copy of power system study and overcurrent protective device settings.
9. Copies of all factory inspections and or equipment start-up reports.
10. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
11. Dimensional drawings of equipment.
12. Detailed parts lists, each with a list of suppliers.
13. Operating procedures for each system.
14. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
15. Repair procedures for major components.
16. Replacement parts and service material requirements for each system and the frequency of service required.
17. Instruction books, cards, and manuals furnished with the equipment.

E. Operation and maintenance data shall consist of written instructions for the care, maintenance, and operation of the equipment and systems. Instruction books, cards, manuals furnished with the equipment shall be included.

F. In addition to the information required by Division 02 for Maintenance Data, include the following information:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions, regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

G. Adequately instruct the Owner's designated representative in the maintenance, care, and operation of the complete systems installed under this contract.

H. Provide verbal and written instructions to the Owner's representatives by factory personnel in the care, maintenance and operation of the equipment and systems.

I. Make DVD format compact disc of the instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video shall become the property of the Owner.

J. The instructions shall include:

1. Maintenance of equipment.
2. Start-up procedures for all major equipment.
3. Description of emergency system operation.

K. Notify the Engineer of the time and place for the verbal instructions to the Owner's representative so his representative can be present if desired.

L. Minimum hours of instruction time for each item and/or system shall be as indicted in each individual specification section.

M. Operating Instructions:

1. Include instructions to the Owner's representatives for the electrical and specialized systems, using factory-authorized technical representatives.

3.20 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 02 Section "Closeout Procedures." In addition to the requirements specified in Division 02, indicate installed conditions for:

1. Raceways of 2-inches and larger, indicating size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Location of every home run point, such as receptacle, lighting fixture, or switch.
4. Approved substitutions, Contract modifications, and actual equipment and materials installed.
5. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; change orders; concealed control system devices.
6. Mark Specifications to indicate approved substitutions, change orders, actual equipment and materials used.

B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.

D. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. Mark all Change Orders, RFI responses, clarifications, and other supplemental instructions on the documents. Record documents that merely reference the existence of the above items are not acceptable. Reimburse the Engineer for all costs for the Engineer to develop record documents which comply with this requirement if unable to comply with said above requirements. Reimbursement shall be made at the Architect or Engineer's hourly rates in effect at the time of the work.

E. Record changes daily and keep the marked drawings available for the Architect or Engineer's examination at any normal work time.

F. Upon completing the job, and before final payment is made, give the marked-up drawings to the Engineer.

3.21 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 02:

B. Final Jobsite Observation:

1. Certify that the project jobsite is ready for the final jobsite observation.
2. Reimburse the Engineer, based on the Engineer's standard hourly rates as defined in their contract with the Owner, for additional time and expenses when additional trips are required because the project jobsite was not ready for final observation and additional trips are required by the Engineer for review of final conditions.
3. Notify the Engineer a minimum of two working days prior to installation of ceiling tiles or lay-in ceilings to allow the Engineer to visit the project site.

C. Submit the following documents to the Architect or Engineer prior to requesting final payment:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including electronic AutoCAD or REVIT drawings and specifications.
3. Documentation of completion of all required training of Owner's personnel.
4. Provide spare parts, maintenance and extra materials in quantities specified in individual specification sections.
5. Inspection and testing reports.
6. Start-up reports on all equipment requiring a factory installation or start-up.

END OF SECTION 26 0500

SECTION 26 0519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Conductors and Cables.
2. Remote Control and Signal Cable.

1.3 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70 “National Electrical Code.”

1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

C. UL Compliance: Provide components which are listed and labeled by Underwriters Laboratories under the following standards.

1. UL Std. 83 Thermoplastic-Insulated Wires and Cables.
2. UL Std. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.

D. NEMA and ICEA Compliance: Provide components which comply with the following standards:

1. WC-70: Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy.

E. IEEE Compliance: Provide components which comply with the following standard.

1. Std. 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Senator Wire & Cable Company.
4. Southwire Company.
5. Cerro Wire.
6. Superior Essex.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN

2.2 CONDUCTORS AND CABLES

A. General: Provide wire and cable suitable for the temperature, conditions and location where installed.

1. All conductors, single (1/0 AWG or larger) or multi, shall be of a type listed and marked for use in cable trays for installations in cable trays.

B. Feeders: Copper, 600 volt insulation, colored per 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper, 600 volt insulation, colored per 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Control Circuits: Copper, stranded conductor, 600 volt insulation IDENTIFICATION FOR ELECTRICAL SYSTEMS.

E. Single Conductors for Feeders and Branch Circuits:

1. Stranding: Provide solid conductors for branch circuits and non-vibrating power utilization equipment utilizing Number 10 AWG and smaller. Provide stranded conductors for Number 8 AWG and larger. Provide stranded conductors, regardless of size, for connections to vibrating equipment such as motors and transformers.

2.3 REMOTE CONTROL AND SIGNAL CABLE

A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket.

B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

C. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60 degrees C, individual conductors twisted together, shielded and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.4 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type and class for application and service required.

PART 3 - EXECUTION

3.1 CONDUCTOR INSULATION, APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Concealed in Ceilings, Walls, Partitions, Raised Flooring and Crawlspaces: Type THHN-THWN, single conductors in raceway.

C. Exposed in Cable Tray: Type THHN-THWN, single conductors in raceway.

D. Class 1 Control Circuits: Install per NEC Article 725.

E. Class 2 Control Circuits: Install per NEC Article 725.

3.2 DEVIATION FROM CONTRACT DRAWINGS

A. Basis of Design is copper conductors installed in raceway, based on 30 degrees C ambient temperature (NEC Table 310.15(B)(16)). If materials or methods selected for installation differ from the basis of design, this contractor shall be responsible for sizing conductors and conduits to meet or exceed the ampacity of circuits selected for the basis of design.

B. Routing multiple conductors within a single conduit requires the conductor ampacity to be derated per National Electrical Code Article 310. Do not provide more than 4 conductors within a single conduit.

C. Where ungrounded conductors are increased in size for any reason, equipment grounding conductors shall be increased in size proportionally according to the circular mil area of the ungrounded conductors.

3.3 INSTALLTION OF CONDUCTORS AND CABLES

A. Install products in accordance with manufacturer's instructions.

B. Completely and thoroughly swab raceway before installing wire.

C. 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.

D. Use pulling means including fish tape, cable, rope, and basket weave wire and cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable. Do not exceed maximum tensile strength of conductor or grip. Do not exceed maximum sidewall pressure limitations of cables.

E. Pull conductors simultaneously where more than one is being installed in the same raceway.

F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

G. Feeder conductors shall be continuous and shall not contain splices.

H. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than Number 10 AWG cabled in individual circuits. Make terminations so there is no more than 1/8 inch of exposed bare conductor at the terminal. Observe NEC 310.15 (B)(2)(a) adjustment factors.

I. Verify that interior of building has been protected from weather and mechanical work likely to damage wire and cable has been completed prior to installing wire and cable.

J. Use conductor not smaller than Number 12 AWG for power and lighting circuits.

K. Single conductors used for control circuits shall not be smaller than Number 14 AWG.

L. Use Number 10 AWG conductors (phase, neutral and ground) for 20 ampere, 120 volt branch circuits longer than 75 feet, unless drawings requirements are more stringent.

M. Use Number 10 AWG conductors (phase, neutral and ground) for 20 ampere, 277 volt branch circuits longer than 200 feet, unless drawings requirements are more stringent.

N. Place an equal number of conductors for each phase, neutral and ground of a circuit within the same raceway or cable when routing parallel conductors. Conductor lengths must be equal.

O. Support cables according to Division 26 Section "Hangers and Supports."

P. Identify and color-code raceways and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS AND TERMINATIONS

A. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

B. Clean conductor surfaces before installing lugs and connectors.

C. Utilize solderless compression terminals applied with circumferential compression for conductor sizes 8 AWG and larger and crimp in accordance with manufacturer instructions. Indenter compression method may be used for conductor sizes 10 AWG and smaller.

D. Phase Sequence: Connections to phase conductors at electrical equipment shall be made such that the A-B-C conductors, when facing the equipment, are oriented top to bottom, or left to right.

E. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 SPLICES AND TAPS

A. Conductor splices shall be kept to a minimum.

B. Only splice within accessible junction boxes or enclosures.

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. Splices and taps shall be capable of carrying the full ampacity of the conductors without perceptible temperature rise.

D. Above Grade:

1. Use copper compression connectors applied with circumferential compression for conductor sizes 6 AWG and larger.
2. Use pre-molded insulated tap connectors for copper conductor splices and taps, Number 8 AWG and smaller. Insulate with UL listed insulating cover supplied by same manufacturer as connector.
3. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, Number 10 AWG and smaller.
4. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor, or three layers of tape, whichever is greater.

3.6 FIELD QUALITY CONTROL

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections with properly scaled and calibrated torque tool and compare torque measurements with manufacturer's recommended values.

C. Before energizing, test wires and cables for electrical continuity and for short circuits.

D. Remove and replace malfunctioning conductors and retest as specified above.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.3 SUBMITTALS

A. Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Ground rods.
2. Ground rings.

1.4 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 UL 467 for grounding and bonding materials and equipment.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled for the specific purposes by Underwriters Laboratories.

D. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.2 CONDUCTORS

A. General: Comply with Division 26 Section "Conductors and Cables" for insulated grounding conductors. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductor: Green insulated; conductor metal shall match branch circuit conductor metal.

C. Grounding Electrode Conductor: Stranded cable.

D. Underground Conductors: Bare, stranded copper except as otherwise indicated.

E. Copper Conductors: Conform to the following:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
3. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
4. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure (clamp) type with at least two bolts.

C. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Pressure Connectors: High-conductivity-plated units.

E. Bolted Clamps: Heavy-duty units listed for the application.

F. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

G. Compression Connectors: Irreversible compression connectors must be factory filled with oxide inhibitor and fully crimped with a 14-ton or larger hydraulic tool so that index number is embossed on the connector. May be used above or below grade.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

1. Size: 3/4 inch diameter by 10 feet length.

PART 3 - EXECUTION

3.1 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. Route grounding electrode conductors within rigid polyvinyl chloride (PVC) conduit.

C. Seal all exterior wall penetrations air-tight.

3.2 GROUNDING ELECTRODES

A. Ground Rods: Provide a minimum of two ground rods separated no less than 20 feet from each other.

1. Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any. Utilize exothermic welds where ground rods are not provided within test wells.
3. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
4. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.3 EQUIPMENT GROUNDINGEquipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.

B. Install separate insulated equipment grounding conductors with all feeders and branch circuit conductors. Terminate each end on a grounding lug or bus.

3.4 CONNECTIONS

A. General: Select connectors, hardware and conductors and make connections in such a manner as to minimize possibility of galvanic action or electrolysis.

1. Make connections with clean bare metal at points of contact.
2. Aluminum to steel connections shall be with stainless steel separators and mechanical clamps.
3. Aluminum to galvanized steel connections shall be with tin-plated copper jumpers and mechanical clamps.
4. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
5. Exothermic Welded Connections or Compression-type Connections: Use for connections to structural steel and for underground connections except those at test wells. Install at

connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable. Compression connections should be inspected for visible die index number matching the die and connector used. Connections that do not show this are not acceptable.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Exothermic-welded or compression-type connectors except at test wells and as otherwise indicated.

C. Equipment Grounding Conductors: Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs.

D. Metallic Raceway Continuity: Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

E. Provide bonding jumper when transitioning from cable tray to conduit.

F. 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 torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A

G. Compression-Type Connections: Use hydraulic compression tools of at least 14-ton size to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

3.5 EQUIPOTENTIAL GROUNDING SYSTEM

A. Bond all non-current-carrying metal parts of equipment, raceways and other enclosures to the grounding system.

3.6 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum unless otherwise noted.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Pad-Mounted Service Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with equipment by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 12 inches from the foundation.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections: After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal 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.

3. Prepare dimensioned drawings locating each ground rod and ground-rod assembly and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals and associated fastenings.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

D. RNC: Rigid non-metallic conduit.

E. 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 four times the applied force.

1.4 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Electrical components shall be listed and labeled for the specific intended purpose by Underwriters Laboratories, Inc.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 COORDINATION

A. Coordinate size, shape and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Slotted Metal Angle and U-Channel Systems:

a. Allied Tube & Conduit.
b. American Electric.
c. B-Line Systems, Inc.
d. GS Metals Corp.
e. Unistrut Diversified Products.

2. Conduit Sealing Bushings:

a. Bridgeport Fittings, Inc.
b. Killark Electric Mfg. Co.
c. O-Z/Gedney.
d. Raco, Inc.
e. Red Seal Electric Corp.

2.2 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic.

2.3 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps.

B. Fasteners: Types, materials and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.
3. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, between one and one half and two and one half inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.4 FABRICATED SUPPORTING DEVICES

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other disciplines' installations.

C. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-inch and smaller raceways serving branch circuits, telephone and data above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
7. Support exposed and concealed raceway within 3 feet of boxes, access fittings, device boxes or cabinets.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway or conductor terminals.
9. Vertical Conductor Supports: Install simultaneously with installation of conductors.
10. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers and other devices.

D. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, motor control centers, disconnect switches and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4-inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment or conduit unless otherwise noted.
4. Do not use powder-actuated anchors without specific permission.
5. Do not drill structural steel members.
6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
7. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

E. In wet locations and on all building floors below exterior earth grade install freestanding electrical equipment on concrete pads.

F. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.2 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

TABLE I: SPACING FOR RACEWAY SUPPORTS

			Maximum Spacing of Supports (Feet)		
Raceway Size (Inches)	**No. of Conduits in Run**	**Location**	**RMC & IMC***	**EMT**	**RNC**
HORIZONTAL RUNS					
1/2, 3/4	1 or 2	Flat ceiling or wall.	5	5	3
1/2, 3/4	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7	--
1/2, 3/4, 1	3 or more	Any location.	7	7	--
1 & larger	1 or 2	Flat ceiling or wall.	6	6	--
1 & larger	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	10	10	--
1 & larger	3 or more	Any location.	10	10	--
Any	--	Concealed.	10	10	--
VERTICAL RUNS					
1/2, 3/4	--	Exposed.	7	7	--
1, 1-1/4	--	Exposed.	8	8	--
1-1/2 and larger	--	Exposed.	10	10	--
Up to 2	--	Shaftway.	14	10	--
2-1/2	--	Shaftway.	16	10	--
3 & larger	--	Shaftway.	20	10	--
Any	--	Concealed.	10	10	--

*Maximum spacings for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.

END OF SECTION 26 0529

SECTION 26 0533 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following raceways electrical wiring:

1. Metallic Conduit and Tubing.
2. Non-Metallic Conduit and Tubing.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. NBR: Acrylonitrile-butadiene rubber.

G. RMC: Rigid metallic conduit

1.4 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70 "National Electrical Code" for components and installation.

C. Comply with NECA "Standard of Installation."

D. Listing and Labeling: Provide products specified in this Section that are listed and labeled by Underwriters Laboratories for the specific purpose and comply with the following standards:

1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
3. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
4. ANSI/NFPA 70 - National Electrical Code.
5. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
6. NECA "Standard of Installation."

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements, and comply with applicable portions of NFPA 70 for raceways.

B. Bushings: Bushings for terminating conduits smaller than 1-1/4 inches are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation. Install insulated type bushings for terminating conduits 1-1/4 inches and larger. Upper edge to have phenolic insulating ring molded into bushing. Bushings to have screw type grounding terminal.

C. Raintight Sealing Hubs: Two piece type with outer internally-threaded hub to receive conduit, inner locking ring with bonding screw, insulated throat, and V-shaped ring or O-ring.

D. Conduit sealing bushings for service entrances: OZ Gedney conduit sealing bushings.

2.2 METAL CONDUIT AND TUBING

A. Rigid Steel (Metallic) Conduit:

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

    a. Allied Tube & Conduit.
    b. LTV Steel Tubular Products Company.
    c. O-Z Gedney.
    d. Wheatland Tube Company.

2. Description: Conduit to be seamless, hot dipped galvanized rigid steel. Threads to be cut and ends chamfered prior to galvanizing. Galvanizing to provide zinc coating fused to inside and outside walls of conduit. Provide an enamel lubricating coating on the inside of the conduit. Conduit to conform to ANSI C80.1 and listed and labeled under UL 6.
3. Fittings and Conduit Bodies: NEMA FB 1, single piece threaded, cadmium plated malleable iron.
4. Joint Compound: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

B. Electrical Metallic Tubing:

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

   a. Allied Tube & Conduit.
   b. LTV Steel Tubular Products Company.
   c. O-Z Gedney.
   d. Wheatland Tube Company.

2. Description: Conduit to be seamless, hot dipped or electro-galvanized steel tubing. Galvanizing to provide zinc coating fused to outside walls of conduit. Provide an enamel lubricating coating on the inside of the conduit. Conduit to conform to ANSI C80.3 - 1983 and listed and labeled under UL 797.
3. Fittings and Conduit Bodies: Compression.
4. Expansion fittings for use with EMT shall allow for a minimum of four inches of movement and shall be similar to O-Z Gedney TX series, complete with bonding jumpers and hardware.

C. Flexible Metal Conduit: Zinc-coated steel.

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

   a. AFC Cable Systems.
   b. Alflex Inc.
   c. Electri-Flex Co.

2. Description: Interlocked steel construction, consisting of spirally wrapped, convoluted hot dip galvanized steel strip. Zinc coating to cover both sides and all edges of steel strip. Convolutions to be interlocked to prevent separation when conduit is bent at radius equal to 4-1/2 times conduit O.D. Conduit to be listed and labeled under UL 1.
3. Fittings: ANSI/NEMA FB 1 -1988. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron.

D. Liquidtight Flexible Metal Conduit:

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

   a. AFC Cable Systems.
   b. Alflex Inc.
   c. Electri-Flex Co.

2. Description: Flexible steel conduit with PVC jacket, listed and labeled under UL 360
3. Fittings: and Conduit Bodies: Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron. Conduit to be listed and labeled under UL 360.

PART 3 - EXECUTION

3.1 METALLIC APPLICATION

A. Indoor Locations:

1. Exposed: RMC
2. Exposed, subject to physical damage below 12’ above floor slab (this includes all conduit in chiller room): RMC.
3. Exposed, subject to physical damage above 12’ above floor slab (this includes all conduit in chiller room): EMT.
4. Wet or Damp Locations: RMC
5. Connections to vibrating equipment: FMC, except use LFMC in wet or damp locations.

B. Conduit Size: Conduits shall be sized as shown on drawings. Where conduit sizes are not indicated, conduits shall be sized in accordance with the latest version of the National Electrical Code (NFPA 70) and shall be limited to a 40 percent conductor fill percentage. Conductor ampacities must be maintained; therefore adjustment factors for temperature and quantity derating values must be observed.

1. Minimum Conduit Size: Unless otherwise noted, 1-inch.

3.2 METALLIC CONDUIT INSTALLATION

A. General Installation Requirements

1. Conduits shall be mechanically and electrically continuous from source of current to all outlets unless a properly sizes grounding conductor is routed within the conduit. All metallic conduits shall be bonded per NFPA 70.
2. Do not reduce the indicated sizes of raceways. Conduit sizes may only change junction and pull boxes.
3. Complete raceway installation before starting conductor installation.
4. Use temporary closures to prevent foreign matter from entering raceway.
5. Avoid moisture traps; provide junction box with drain fitting at low points in raceway system.
6. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Empty raceways shall be labeled at each end indicating origin of the raceway. Labels shall be self-adhesive vinyl labels.
7. This contractor shall be responsible for all openings required in masonry or exterior walls for conduit routing. A qualified contractor capable of repairing all openings in a manner that matches existing conditions shall be hired by the electrical contractor.

B. Conduit Routing:

1. In general, conduit shall be exposed within unfinished spaces (such as mechanical and utility areas).
2. Raceway routing proposed on Drawings is diagrammatic in nature and shown in approximate locations unless dimensioned. Coordinate conduit routing with beams, joists, columns, windows, etc., as required to complete wiring system. Verify field measurements,

routing and termination locations of raceway with obstructions and other trades prior to rough-in. The electrical contractor shall be responsible for any expense due to the failure of coordination between other trades to ensure fit and avoid conflict.

3. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.
4. Route exposed conduit and conduits parallel and perpendicular to building structural lines, and as close to building structure as possible.
5. Raceways are not to cross pipe shafts or ventilating duct openings, nor are they to pass through HVAC ducts. Maintain adequate clearance between raceway and piping.
6. Coordinate layout and installation of conduit with other construction elements to ensure adequate headroom, working clearance and access.
7. Route conduit through roof openings provided for piping and ductwork or rooftop unit curbs where possible. Where unavoidable, route conduit through suitable roof jack with pitch pocket. Coordinate roof penetrations with other trades.
8. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Conduit Supports:

1. Install raceways level and square and at proper elevations. Provide adequate headroom. Group related conduits; support using conduit rack. Construct rack using steel channel. All conduit supports shall be secured to walls, structural members, slabs and bar joists. Do not support conduits from non-structural members, such as ductwork, water or fire suppression piping.
2. Run parallel or banked raceways together, on common support racks where practical and make bends from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways. Provide space within each rack for 20 percent additional conduits.
3. Support raceways as specified in Division 26 Section "Hangers and Supports."

D. Conduit Fittings and Terminations:

1. 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.
2. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
3. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank coverplate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings where conduits enter or leave hazardous locations, where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, such as kitchen cold boxes, air-conditioned spaces and other places indicated on the drawings or required by NFPA 70.
4. Expansion/Deflection Joints: Provide suitable fittings to accommodate expansion and contraction where raceway crosses seismic and expansion joints. Install expansion fittings in the full open position if installed during a period of lowest expected temperature, and in

the fully closed position if installed during a period of highest expected temperature. Install at proportionate intermediate position for intermediate temperatures.

a. In addition to the foregoing, provide expansion fittings according to the following table, for exposed linear runs or runs in hung ceilings where such runs do not contain junction boxes, pull boxes, nor bends totaling more than 30 degrees.
b. EMT and RMC expansion couplers shall be UL listed with an internal copper braided bonding jumper that meets the requirements of NEC 250.98. Fitting shall be listed as suitable for wet locations and rain water tight when installed in wet or outdoor locations.

Raceway Material	Indoor, conditioned areas	Indoor, non-conditioned areas
Steel	One expansion fitting in runs longer than 80 feet, additional expansion fittings every 400 feet	One expansion fitting in runs longer than 40 feet, additional expansion fittings every 200 feet

5. Flexible Connections: Use maximum of 6 feet of flexible metal conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement and for all motors. Use Liquidtight flexible metal conduit in wet or damp locations. Install ground conductor across flexible connections.
6. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

E. Conduit Bends:

1. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
2. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
3. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender when field-fabricated elbows are required for bends in metal conduit larger than 2 inch size.
4. Stub-Up Connections: Use type of conduit described for stub-ups from slab. Extend conduit through concrete floor for connection to freestanding equipment to a distance 6-inches above the floor. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.5 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches and abrasions.

3.6 MARKING AND IDENTIFICATION

A. Mark and identify conduits in accordance with Section 26 0553 “Identification for Electrical Systems.”

3.7 RECORD DOCUMENTS

A. Accurately record actual routing of all feeder and sub-feeder conduits regardless of size and branch circuits conduits larger than 2-inches.

END OF SECTION 26 0533

SECTION 26 0534 – BOXES, CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes boxes, cabinets and enclosures for electrical wiring.

1.3 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with the following standards:

1. NECA "Standard of Installation."
2. NEMA OS 1: Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
3. NEMA OS 2: Non-Metallic Outlet Boxes, Device Boxes, Covers and Box Supports.
4. NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
5. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. General: Outlet boxes shall be constructed in accordance with National Electrical Code Article 314. Outlet boxes shall be sized for the volume required by the National Electrical Code, but in no case shall they be less than 1-1/2 inches deep.

B. Sheet Metal Boxes: Comply with NEMA OS 1, galvanized steel.

C. Cast Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, type FD with gasketed cover and threaded hubs.

D. Boxes for receptacle, telephone and data outlets shall be 4-11/16 inches square by 2-1/8 inches deep and shall be provided with extension rings. Furnish outlet boxes with fixture studs where required.

E. Boxes for switches or local light control shall be 4 inches square by 1-1/2 inches deep and shall be provided with raised cover to fit flush with finished wall line. Provide single box for multiple-ganged devices with single coverplate, sized for the quantity of devices to be installed.

F. Provide 4-inch octagonal and square outlet boxes for all exposed conduit work with fixture extension pan or deep fixture canopy to enclose the outlet box.

G. Provide corrosion-resistant steel knockout closures for unused openings.

2.2 JUNCTION AND PULL BOXES

A. Small Sheet Metal Pull and Junction Boxes: Comply with NEMA OS 1, galvanized steel. Flush-mounted boxes shall have an overlapping cover.

B. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1, galvanized with gasketed cover.

C. Stainless Steel Pull and Junction Boxes: Stainless steel NEMA 4X with gasketed cover.

D. Covers: Covers shall be the same material as the box. Covers shall be on the largest access side of the box, unless otherwise indicated.

1. Less than 12 inches in any dimension: Screw-on cover.
2. Greater than 12 inches in any dimension: Hinged cover.

PART 3 - EXECUTION

3.1 BOX AND CABINET INSTALLATION

A. General Installation Requirements:

1. Electrical boxes are shown on drawings in approximate locations unless dimensioned. The Engineer or Owner shall be allowed to adjust the location of boxes up to 10 feet in any direction without additional cost to the project. This is intended for boxes for receptacles and switches and other wiring devices.
2. Provide boxes as shown and for splices, taps, wire pulling, equipment and fixture connections and where required by applicable codes and installation practices.
3. Locate boxes to maintain headroom and present a neat appearance. Locate to allow proper access. Provide access doors for boxes located above inaccessible ceilings.
4. Provide knockout closures to cap unused knockout holes where blanks have been removed.
5. Support all boxes, cabinets and enclosures rigidly and independently of conduit except where specifically allowed by the National Electrical Code. Use supports suitable for the purpose.
6. Boxes located outdoors above ground shall be raintight and gasketed cast aluminum.
7. Provide covers for all boxes.

B. Outlet Box Installation:

1. All devices (receptacles, switches, and any other device) furnished under this project shall be mounted on or in an outlet box regardless of whether or not the associated system wiring is in conduit, unless otherwise noted.
2. Outlets in mechanical rooms, electrical rooms, and the above removable ceilings may be surface-mounted.
3. Use multiple gang boxes where more than one device is mounted together. Provide barriers to separate different voltage systems.
4. Adjust outlet mounting height and horizontal location to agree with required location for equipment served as may be shown on installation instructions or shop drawing for the equipment.
5. Outlet Box Application: Unless otherwise noted, outlet boxes shall be installed as follows:

a. Galvanized Steel Box Installation Locations:

1) Concealed interior locations.
2) Exposed interior locations above 7 feet-0 inches of finished floor.

b. Cast Box Installation Locations:

1) Exposed interior locations within 7 feet-0 inches of finished floor.
2) Wet or damp locations.
3) Direct contact with earth or concrete slabs on grade.

c. Stainless Steel Box Installation Locations:

1) Exterior locations.

3.2 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.4 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.5 MARKING AND IDENTIFICATION

A. Mark and identify boxes, cabinets and enclosures in accordance with Section 260553 "Identification for Electrical Systems."

END OF SECTION 26 0534

SECTION 26 0536 - CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cable trays.
2. Cable tray accessories.

1.3 SUBMITTALS

A. Product Data: Include for each tray type, dimensions, support points, clamps, hangers, connectors, fittings, expansion joint assemblies, accessories and finishes.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.

    a. Design Calculations: Calculate requirements for selecting seismic restraints.
    b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

C. Coordination Drawings: The contractor shall be responsible for coordinating the cable tray layout with all building components (ducts, pipes, fire protection, columns, beams, walls, etc.). Make changes in cable tray direction and elevation as required. Provide floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components 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 the following codes and standards:

1. NFPA 70.
2. ASTM B 633.
3. ASTM F 593.
4. ASTM F 594.
5. ASTM F 1136.

1.5 DELIVERY, STORAGE AND HANDLING

A. Steel cable tray, galvanized may be stored outside without cover, but shall be loosely stacked, elevated off the ground, and ventilated to prevent staining during storage.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the drawings for specific requirements for types, materials, sizes, and configurations in specific locations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 2.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 ACCEPTABLE MANUFACTURERS

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

1. Legrand Cablofil.
2. PW Industries.
3. Cooper B-Line, Inc.
4. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
5. MONO-SYSTEMS, Inc.
6. MPHusky.
7. Chalfont Manufacturing Company.
8. Thomas & Betts.

2.4 LADDER-TYPE CABLE TRAYS

A. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 9 inches on center.
3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 6 inches.
8. Straight Section Lengths: 10 feet except where shorter lengths are required to facilitate tray assembly.
9. Width: 12 inches unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 12 inches
11. Class Designation: Comply with NEMA VE 1, Class 12B
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: Steel, zinc plated
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

B. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Mill galvanized before fabrication.

1) Standard: Comply with ASTM A 653/A 653M, G90 (Z275).
2) Hardware: Galvanized

C. Cable Tray Accessories:

1. Accessories: Provide all supporting, hanging, tee, cross, level change, reducing, drop outs, and miscellaneous hardware as required for a complete and functioning installation to manufacturer's recommendations.
2. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
3. Barrier Strips: Same materials and finishes as for cable tray.
4. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

D. Cable Drop-outs ("Waterfalls"):

1. Shall mount securely to ladder rack rails and shall maintain minimum bend radius on all cables entering or exiting the Ladder Rack.

E. Cable Fencing:

1. Minimum 7 inches high, at 3 feet-0 inches on center for entire route of cable tray.

2.5 WARNING SIGNS

A. Provide manufacturer's standard, permanent, legible warning label indicating the following:

WARNING! DO NOT USE AS A WALKWAY, LADDER, OR SUPPORT FOR PERSONNEL. TO BE USED ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

B. Label shall also indicate cable tray NEMA load class. Label shall be a maximum of 10' on center.

C. Cable trays containing conductors rated over 600 volts shall have a label with the wording "DANGER-HIGH VOLTAGE-KEEP AWAY."

D. Cable trays containing service entrance conductors shall be labeled with "CABLE TRAY CONTAINS SERVICE-ENTRANCE CONDUCTORS."

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements

1. Refer to the drawings for specific cable tray routings, sizes, types, and accessories to be installed in specified locations.
2. Cable tray shall be installed parallel and perpendicular to building structural and wall lines.
3. Install cable tray in accessible locations only.
4. Install in conformance with NEMA VE 2 requirements and in accordance with manufacturer's instructions.

5. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 8 feet maximum.
6. Tray shall be electrically continuous from source to termination and shall not change elevation, direction or otherwise expose cables to travel without support.
7. All splices of tray shall be provided with splice washers, bars or springs as recommended by the manufacturer.
8. Provide bonding continuity between cable tray sections, fittings and conduit terminations in accordance with manufacturer's instructions.
9. 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.
10. Remove burrs and sharp edges from cable trays.
11. Install cable trays with sufficient space to permit access for installing cables. Install tray bottom within 18 inches of access ceiling paneling for ease of access. Adjust mounting height only momentarily for field coordination with other trades and systems as required.
12. Provide separation of cables of different systems, such as power, telecommunications, fire alarm system, security systems and audio or visual systems. Install barriers between power and low voltage cables.
13. Install cable trays according to NEMA VE 2.
14. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
15. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
16. Fasten cable tray supports to building structure.
17. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems."
18. Place supports so that spans do not exceed maximum spans and provide clearances as required. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
19. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
20. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
21. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
22. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
23. The contractor shall be required to make changes in direction and elevation in order to provide a continuous cable tray routing as indicated on the construction documents and engineer approved coordination drawings. Changes in direction and elevation shall be made using manufacturer's recommended fittings.
24. Make cable tray connections using manufacturer's recommended fittings.
25. Install cable trays with enough workspace to permit access for installing cables.
26. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

27. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems."

B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

C. Install cables only when cable tray installation has been completed and inspected.

D. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

E. On vertical runs, fasten cables to tray every 18 inches (457 mm). Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

F. Ground cable trays according to manufacturer's written instructions.

G. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 0536

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Identification for raceways.
2. Identification for wires, cables and conductors.
3. Warning labels and signs.
4. Instruction signs.
5. Equipment identification labels.
6. Miscellaneous identification products.

1.3 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.4 QUALITY ASSURANCE

A. Comply with the following standards:

1. ANSI A13.1 and IEEE C2.
2. NFPA 70.
3. 29 CFR 1910.144 and 29 CFR 1910.145.
4. ANSI Z535.4 for safety signs and labels.

B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices 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

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Electromark - Wolcott, New York.
2. Ideal Industries, Inc.
3. 3M.
4. Panduit Corp.
5. Seton Name Plate Co.
6. Thomas & Betts.
7. W. H. Brady, Co. - Signmark Division - Milwaukee, Wisconsin.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

A. Self-Adhesive Vinyl Labels (Raceways and Boxes): Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

B. Self-Adhesive Vinyl Tape for Banding (Raceway): Colored, heavy duty, waterproof, fade resistant; 2 inches wide.

C. Self-Adhesive Tape Markers (Wire and Cable): Vinyl or vinyl-cloth, self-adhesive, wraparound, cable and conductor markers with preprinted numbers and letters.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

E. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

F. Snap-Around, Color-Coding Bands (Raceways): Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

G. Colored Adhesive Marking Tape (Raceways): Self-adhesive plastic coated cloth tape similar to Brady 441XX or 442XX series.

H. Conductor Identification Products:
1. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application with 1/4-inch (6.4-mm) grommets in corners for mounting, nominal 7 by 10 inches in size unless noted otherwise.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. Provide 1/4-inch (6.4-mm) grommets in corners for mounting, nominal 10 by 14 inches in size unless noted otherwise.

E. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with eyelet for fastener.

F. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face and punched for mechanical fasteners.

2.4 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Overlay shall provide a weatherproof and UV-resistant seal for label. Labels shall be at least 2-1/4 inches high. Where space does not permit this label size, smaller stock and lettering is permitted.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with lettering and background colors as indicated. Labels shall be at least 2-1/4 inches high. Where space does not permit this label size, smaller stock and lettering is permitted.

C. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Labels shall be at least 2-1/4 inches high. Where space does not permit this label size, smaller stock and lettering is permitted.

2.5 CABLE TIES

A. Cable Ties: Fungus-inert, self-extinguishing, nylon one-piece, self-locking cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a minimum temperature range from minus 50 degrees F to 350 degrees F. Provide ties in specified colors when used for color-coding.

B. Identification Cable Ties: Same as "Cable Ties" above, except with integral tab of suitable size for marking requirements.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior). Comply with maximum volatile organic compound levels imposed within Division 09.

B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Increase size of labels and letters to those appropriate for viewing from the floor for elevated components.

C. Lettering and Graphics: Coordinate names, abbreviations, colors and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering and colors as required by code.

D. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

E. Clean and degrease surfaces prior to applying identification products. Apply identification to surfaces that require finish after finish work is completed. Utilize primer for metal surfaces, heavy-duty acrylic resin block filler for concrete masonry, and clear alkali-resistant alkyd binder-type sealer for concrete surfaces.

F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

G. 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 (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

3.2 LABEL COLOR CODE LEGEND

A. Provide the following color coding scheme for each label based on the power system it is identifying:

1. Normal Power: Black letters on white background.

3.3 RACEWAY IDENTIFICATION

A. Identify Raceways of Certain Systems with Color Banding: Band exposed and accessible raceways of the following systems for identification. Bands shall be pre-tensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches wide, completely encircling conduit and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors and at 20-foot maximum intervals in straight runs. Apply the following colors:

1. Normal Distribution System (208/120V): White.
2. Normal Distribution System (480/277V): Orange.
3. Ground: Green.
4. Fire Alarm System: Red.
5. Motor and Control Systems: Black.
6. Temperature Controls/Building Automation: Blue.

B. Where conduits leave a switchboard, panelboard, motor control center, etc., identification shall be provided on each conduit indicating the load being served.

C. Contractor shall be responsible for providing the Owner with laminated, colored, typewritten legends indicating the identification color scheme. At a minimum, these legends should be installed in the main electrical room and branch electrical closets. Provide two additional legends to the Owner to use at their discretion.

D. Identification of Raceways with Labeling:

1. Raceway Labeling: Provide labeling on conduits indicating electrical distribution system contained within (e.g. Normal, Life Safety, etc.) and operating voltage level. Label size shall be as follows:

Nominal EMT conduit size	**Nominal RGS conduit size**	**Length of color background on label**	**Height of letters**
up to 1 inch	up to 3/4 inch	8 inches	1/2 inch
1.25 to 1.5 inches	1 to 1.5 inches	8 inches	3/4 inch
2 to 5 inches	2 to 5 inches	12 inches	1.25 inches
6 inches	6 inches	24 inches	2.5 inches

3.4 BOX IDENTIFICATION

A. Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage:

1. Normal Power.

B. At each junction, pull and connection box, identify the following: with self-adhesive vinyl labels or permanent marker (color coded) neatly hand-printed. Identification of these boxes shall be located on the inside of cover if located in finished spaces:

1. Power and lighting circuits: Indicate system voltage and identify contained circuits and panelboard serving load (e.g., “120V, PP1-1, 3, 5”).
2. Other wiring: Indicate system type and wiring description (e.g., “FIRE ALARM NAC #2”).

3.5 CIRCUIT IDENTIFICATION

A. Label conductors as follows:

1. Multiple Power or Lighting Circuits in the Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications signal/wiring, use wire/cable marking tape at terminations in wiring boxes, troughs and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

3.6 CONDUCTOR COLOR CODING

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, panelboards, manholes, handholes, switches, cable trays, etc., use color-coded insulation to identify the phase per the following:

1. Color-Coding for Conductors rated 600 V or Less: Use colors listed below for all conductors.

a. Colors for 208/120V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral: White.
5) Ground Bond: Green.

b. Colors for 480/277V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

4) Neutral: Gray.
5) Ground Bond: Green.

B. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control and signal connections.

1. Identify conductors, cables and terminals in enclosures and at junctions, terminals and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

3.7 RECEPTACLE IDENTIFICATION

A. Identification Material: Pre-printed, self-laminating vinyl labels, 3/16-inch font height. Utilize black lettering on clear background for normal power circuits.

B. Coverplates: Provide identification on all receptacle coverplates indicating the source panelboard and circuit number serving the device (e.g., PP1#1).

3.8 SIGNAGE

A. Install instructional sign in each electrical room including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

B. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution or operating instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install fiberglass signs or outdoor items.
2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding or other emergency operations where required by NEC or where required to assure safe operation and maintenance.
3. Arc Flash Hazard Warning: Provide signage on all electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures and motor control centers indicating arc flash hazard warning and advising appropriate PPE.

3.9 ELECTRICAL EQUIPMENT IDENTIFICATION

A. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, one-line diagram, schedules and the Operation and Maintenance Manual. Each section of a multiple-section equipment lineup shall be provided with its own identification label. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets and racks of each system. Systems include power, lighting, control, communication, signal, monitoring and alarm systems unless equipment is provided with its own identification.

B. Labeling Instructions:

1. Indoor Equipment: Provide self-adhesive, engraved, laminated acrylic or melamine label
2. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
3. Nameplate Data: Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances and similar essential data. Locate nameplates in an accessible location.
4. Fusible Switches: Install fuse manufacturer-supplied labels inside the door of the fusible switch indicating the proper type and fuse required for replacement.
5. Automatically Started Equipment: Provide adhesive label reading "DANGER - WARNING THIS MACHINE IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME" on all motors, generators and other moving or hazardous equipment which is remotely or automatically operated. Sign to be similar to Brady Number 88191.

C. Specific Equipment Requirements:

1. Power Distribution Equipment: Including, but not limited to switchgear, switchboards, distribution panelboards, branch panelboards and motor control centers.

a. Identification label shall include the following:

1) Equipment type and tag designation shown on the contract documents using 1/2 inch high bold lettering.
2) Voltage and phase rating of the equipment using 1/4 inch high bold lettering.
3) The name of the upstream equipment and location/room number it is located in using 1/4 inch high bold lettering.
4) Rating and type of overcurrent protection device serving the equipment (e.g., “FED FROM 200A/3P CIRCUIT BREAKER”) using 1/4 inch high bold lettering.

b. Example Identification Label:

DISTRIBUTION PANEL ‘DP1’
208Y/120V 3-Phase 4-Wire
Fed from Panel MP1; Room 200
Fed from 200A/3P Circuit Breaker

c. A separate nameplate shall be provided at the service entrance equipment for all sources of power indicating the maximum available fault current and the date the fault current calculation was performed.
d. Distribution panelboards and switchboards shall be provided with permanent labeling adjacent to each overcurrent protection device indicating the load being served and the location of the equipment.
e. A typewritten directory of circuits shall be provided at all branch panelboards. Provide explicit description and identification of items served by each individual switch and circuit breaker.

2. Control Equipment: Including but not limited to disconnect switches, starters, variable-speed controllers, contactors, motor control centers, pushbutton stations, etc.

   a. Identification label shall include the following:

      1) Equipment type and tag designation shown on the contract documents of the actual equipment served in 1/2 inch high bold lettering.
      2) Location of equipment being served in 1/4 inch high bold lettering. If the equipment being served by the control equipment is located in the same room, identify location as "THIS ROOM."
      3) Voltage and phase rating of equipment in 1/4 inch high bold lettering.
      4) The name of the upstream equipment and location/room number it is located in using 1/4 inch high bold lettering.

   b. Example Identification Label:

AHU-6 Supply Fan 'AHU-6S'
Located in Mechanical Room 001
480V 3-Phase, 3 Wire
Fed from Distribution Panel MHEQ; Room 200

END OF SECTION 26 0553

SECTION 26 0600 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Electrical coordination, materials and methods for electrical demolition associated with remodeling of an existing area or facility for re-use.

1.3 SELECTIVE DEMOLITION

A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:

B. Selective demolition including:

1. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
2. Dismantling electrical materials and equipment made obsolete by these installations.
3. Miscellaneous metals for support of electrical materials and equipment required to remain.
4. Firestopping as required to maintain existing partition ratings.

1.4 PROJECT CONDITIONS

A. Conditions Affecting Selective Demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
3. Maintain and protect existing building services that transit the area affected by selective demolition.

1.5 SEQUENCE AND SCHEDULING

A. Coordinate the shut-off and disconnection of electrical, fire alarm and communication services with the Owner and the utility companies. Coordinate any electrical outages required for service switchovers or connections with the Owner a minimum of five working days prior to the interruption. Comply with Owner's specific requirements for partial or complete outage requests.

B. All work that produces excessive noise and/or interference with normal building operations, as indicated on the drawings, shall be coordinated and scheduled with the Owner.

C. Assume that all required re-connection of existing systems or equipment not indicated for demolition must remain operational unless otherwise noted. Provide temporary connections to maintain electrical services and systems serving adjacent areas during required outages.

D. Maintain existing electrical service, electrical distribution, fire alarm and communication equipment in operation until the new electrical service or distribution equipment is energized, tested and accepted.

1.6 DRAWINGS AND SPECIFICATIONS

A. The architectural, structural, mechanical and electrical drawings and specifications shall be considered as mutually explanatory and complementary. Any electrical demolition work called for by one and not by the other shall be performed as though required by all. All sections and subsections of the Electrical work shall be governed by and subject to the general and supplementary conditions. Any discrepancies in or between the drawings and specifications, or between the drawings and actual field conditions shall be reported to the Engineer/Architect in sufficient time to issue an addendum for clarification.

B. The electrical drawings are diagrammatic and the drawings indicate the general layout of the electrical systems. Field verification of scale dimensions on plans is directed since actual locations, distance and levels will be governed by actual field conditions.

PART 2 - PRODUCTS

2.1 MATERIALS AND METHODS

A. Materials and methods required for removing, patching, connections, etc., shall be as specified in the associated specification sections.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL DEMOLITION

A. Comply with NECA 1.

3.2 EXAMINATION AND COORDINATION

A. Examine substrates, areas and conditions with Installer present for compliance with requirements for conditions affecting demolition.

B. Coordinate the demolition scope of work with the Owner and other Contractors to confirm that all required electrical demolition is addressed and scheduled to avoid disputes.

3.3 SELECTIVE DEMOLITION

A. The Electrical Contractor shall remove, cap and/or relocate equipment, outlets, conduit, wire, etc., as shown and specified on drawings and as may become necessary because of existing field

conditions. It shall be the responsibility of the Electrical Contractor to visibly examine all existing walls designated for removal to determine the conduit and the wiring that will require capping and/or removal, whether or not such conditions are indicated on the drawings. The contractor shall be held to having visited the site and taken all existing conditions into consideration.

B. Where the architectural drawings indicate that partitions, walls, ceilings, etc., are to be removed the Electrical Contractor shall be responsible for removal of all electrical components within those structures including equipment, lighting fixtures, lighting controls, wiring devices, raceways, wiring, electrical systems, etc.

C. In addition to the foregoing, comply with the following:

1. Maintain circuit continuity to all existing fixtures, equipment, outlets, etc., to remain in use whether noted on the plans or not. Field-verify existing items to remain in use. Wiring for existing circuits which must be re-routed or which are partially abandoned, shall be reconnected to service the remaining outlets on the circuit.
2. In the demolition work, remove all unused wiring and cables and unused conduit that is exposed or within accessible ceilings which is affected by and is in the area of the work of this contract.

D. The intention of the electrical demolition drawings is to disconnect and remove all electrical work made void by the scope of the construction and alteration. Field-verify exact material quantities required to be removed.

E. Abandoned electrical power distribution equipment, including switchboards, motor controllers, panelboards, lighting fixtures and controls and wiring devices shall be disconnected and removed unless otherwise noted. All supporting equipment for this equipment to be removed, including hangers, supporting rods, ballasts, etc., shall be removed.

F. All existing electrical work and associated raceway and wiring, which has been made obsolete by the work and/or is shown dashed on the electrical demolition drawings shall be disconnected and removed back to the source of power unless otherwise noted. Although an attempt has been made to indicate all of this work, total accuracy is not guaranteed. Contractor shall visibly examine all areas and walls and ceilings scheduled for removal to determine existing electrical items to remain.

G. Where electrical equipment, conduit, boxes and supporting hardware are removed, patch and finish the surface as required to match the existing unless otherwise noted.

H. Where buried conduits extending out of a concrete slab become abandoned, cut and grind the conduits off flush with top of slab and plug with non-shrink waterproof grout fill.

I. All removed materials, other than removed materials to be relocated, or stored or turned over to the Owner shall become the property of the Contractor and shall be removed from the project site.

J. Acceptance of contract means installer accepts existing conditions.

K. Contractor shall coordinate all demolition work with all other trades.

L. In walls or floors where a flush device is being removed, but the wall or floor remains or for any outlet which must remain, but has a device removed, provide a blank cover over the outlet. Match the color and material of existing remaining covers in the room or space.

M. In areas where the partitions, ceilings, etc., are indicated to be temporarily removed, the Electrical Contractor shall be responsible for the disconnection, storage, re-installation and re-connection of equipment or devices within that partition, ceiling, etc., unless otherwise noted.

N. Legally dispose of hazardous materials and ballasts or other equipment containing PCBs and lamps containing mercury or equipment containing oil. Comply with all Federal, state, and local laws. This includes HID and fluorescent lamps determined to be hazardous waste. These shall be disposed of at a permitted hazardous waste disposal facility or other appropriately permitted entity.

O. Provide manifests and travel and disposal forms and documents to Owner when required by Owner or regulatory agencies.

3.4 CLEANING

A. Clean existing electrical distribution equipment affected by the project, including switchboards, motor controllers, panelboards, etc. Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide coverplates for openings. Modify existing panelboard directories (or replace) for panelboards which have had alterations to the circuits originating therein. Describe the load and location.

B. Where luminaires are indicated to be retained and re-used, the Electrical Contractor shall clean all exterior and interior surfaces. Lamps and ballasts shall be replaced with new. Broken electrical parts, including guards and lens shall be replaced to match existing construction unless otherwise noted.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical demolition to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 26 0500

SECTION 26 0913 – ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following:

1. Equipment meters.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For equipment meters provided under this section.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Cost to repair or replace any parts for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with the following for installation of metering infrastructure:

1. ANSI
2. NEC
3. IEEE C12

C. Equipment meters (EMON meters) for energy monitoring will be provided and installed by the contractor along with all fuse blocks, fuses, enclosures, conduit and wire as required for a complete and operational system per the owners standards.

2.2 ELECTRICITY METERS

A. Equipment meters for energy monitoring (EMON Meters):

1. Meters for energy monitoring are provided and installed by the contractor.

2. Provide and install an energy meter for each Variable Frequency Drive indicated on project electrical drawings. Energy meters shall be as follows and as specified on the drawings:

    a. Manufacturers: Subject to compliance with requirements, provide the following products:

        1) E-Mon Energy Monitoring Products – Class 5000 Smart Meter

    b. Meter shall be fully electronic with 4 line LCD display showing kwh.
    c. Meter shall utilize 0-2 volt AC output current sensors to allow paralleling and/or mounting up to 500 feet from the meter. Sensors shall be of split-core configuration to allow installation without disconnecting cabling, etc. Sensors shall be available from 100 amp to 3200 amp. Sensors shall be optionally available in solid-core configuration (100 & 200 amp.)
    d. Meter shall provide current sensor installation diagnostics indicator, phase error indicator and phase angle diagnostics on display.
    e. Meter shall be field programmable for meter date/time, IP address and ID code for communication options.
    f. Meter shall be enclosed in a NEMA 4X polycarbonate enclosure (standard) with padlocking hasp & mounting flanges for indoor/outdoor installation (stand alone) with one 1 1/16” KO on bottom of enclosure. Optional heavy duty JIC steel enclosure available for indoor installation.
    g. Meter shall be UL/CUL Listed to latest applicable standards for safety.
    h. Meter shall meet or exceed ANSI C12.20 accuracy standards.
    i. Meter shall provide non-volatile memory to maintain reading during power outages.
    j. Meter shall store interval data for kW and kVAR for up to 72 days in first-in first-out format.
    k. Meter works as a master device on BACnet MS/TP.
    l. Meter shall provide optional 5th & 6th channel for logging inputs from third-party metering devices (gas, water, BTU, etc.) Both channels provide interval data logging that can be read via E-Mon Energy software and Modbus.
    m. Meter shall be capable of daisy-chain or star connection using RS-485 communications in combinations of Class 3200s, 3400s, 5000s, IDR-8s, IDR-16s not to exceed 52 devices. Cabling shall be through RJ-11 modular jack (4-conductor) or terminal block (3-conductor), 18-26 AWG, up to 4,000 cable feet total.
    n. Meter shall be MV-90 compatible.
    o. Meter shall provide real time kw data via BacNET.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment meters per manufacturer’s instructions and as specified on the drawings.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

END OF SECTION 260913

SECTION 26 2413 – SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.

1.3 SUBMITTALS

A. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Comply with NEMA PB 2 “Deadfront Distribution Switchboards.”

C. Comply with NFPA 70 “National Electrical Code.”

D. Comply with UL 891 “Deadfront Switchboards.”

1.5 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery to project site with Owner’s representative. Contractor shall assume costs associated with obtaining VFD from Owner’s storage facility and transportation to project site for installation and final connections.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris and traffic.

C. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure and finish.

D. Handle and prepare switchboards for installation according to NECA 400 "General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards." Use factory-installed lifting provisions.

1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight; work in spaces is complete and dry; work above switchboards is complete; and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

PART 2 - PRODUCTS

2.1 OWNER FURNISHED; CONTRACTOR INSTALLED.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and in accordance with manufacturers' written installation instructions and the following specifications.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for Concrete Bases specified in Division 26 Section "Common Work Results for Electrical."

C. Anchor each switchboard assembly to slab or housekeeping pad (as indicated) using bolt sizes and types and quantities as recommended by manufacturer and to meet seismic force requirements. When secured to a pad that is separately poured, the bolts are to be installed through the pad and into the slab. Use appropriate length bolts.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels and brackets and temporary blocking of moving parts from switchboard units and components.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Comply with NECA 1.

3.2 GROUNDING

A. Connections: As indicated. Tighten connections to comply with tightening torques specified in UL 486A.

B. Ground equipment according to the contract documents and the National Electrical Code.

3.3 CONNECTIONS

A. Tighten switchboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not stated, use those specified in UL 486A.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems." Nameplate to display switchboard name, voltage, phase, and supply circuit origin. Include permanent one-line diagram.

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate to show the load it supplies complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section “Identification for Electrical Systems.”

3.5 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage and grounding.

B. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each. Test voltage shall be 1000 volts and minimum acceptable value for insulation resistance is 2 megohms.

C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.

D. Physically test key interlock systems to ensure proper function.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated on the drawings or as instructed by the engineer.

3.7 CLEANING

A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt and debris. Touch-up scratches and mars of finish to match original finish.

END OF SECTION 26 2413

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fuses.
2. Spare-Fuse Cabinets.

1.3 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.4 QUALITY ASSURANCE

A. Source Limitations: All fuses shall be the product of a single manufacturer.

B. Comply with NEMA FU 1 and NFPA 70.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 degrees F (5 degrees C) or more than 100 degrees F (38 degrees C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 EXTRA MATERIALS

A. Spare Fuses: Furnish quantity equal to 1 set of 3 fuses of each fuse type and size installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Edison Cooper, Inc.
3. Mersen.
4. Littelfuse, Inc.

2.2 FUSES

A. Characteristics: NEMA FU 1 nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. Cartridge Fuses: Cartridge fuses shall be as described below and shall have a minimum interrupting rating of 200,000 symmetrical amperes for the a.c. voltage at which they are rated.
   1. Fuses rated greater than 200 amperes and less than or equal to 600 amperes: Provide UL class RK-1 dual element time delay fuses.
   2. Control circuit fuses: Provide UL class CC (time delay) fuses.
   3. Where the Drawings show a specific fuse type, the Drawings shall supersede the above types.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

3.2 INSTALLATION

A. Install fuses in fusible devices in accordance with manufacturer instructions. Arrange fuses such that label and rating information is readable without removing fuse.

END OF SECTION 26 2813

SECTION 26 2923 - VARIABLE-FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes AC Motor Variable Frequency Drives rated 600 V and less.

1.3 REFERENCES

A. ANSI/UL Standard 508.

B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

C. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference.

E. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems; National Electrical Manufacturers Association.

F. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; National Electrical Manufacturers Association.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

H. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.4 DEFINITIONS

A. BAS: Building automation system.

B. CPT: Control power transformer.

C. EMI: Electromagnetic interference.

D. IGBT: Insulated-gate bipolar transistor.

E. LAN: Local area network.

F. LED: Light-emitting diode.

G. MCP: Motor-circuit protector.

H. NC: Normally closed.

I. NO: Normally open.

J. OCPD: Overcurrent protective device.

K. PCC: Point of common coupling.

L. PID: Control action, proportional plus integral plus derivative.

M. PWM: Pulse-width modulated.

N. RFI: Radio-frequency interference.

O. TDD: Total demand (harmonic current) distortion.

P. THD(V): Total harmonic voltage demand.

Q. VFD: Variable-frequency drive.

1.5 SUBMITTALS

A. Test Reports: Indicate field test and inspection procedures and test results.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation**,** and installation of product.

C. Manufacturer's Field Reports: Indicate start-up inspection findings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery to project site with Owner’s representative. Contractor shall assume costs associated with obtaining VFD from Owner’s storage facility and transportation to project site for installation and final connections.

PART 2 - PRODUCTS

2.1 OWNER FURNISHED; CONTRACTOR INSTALLED.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in accordance with NEMA ICS 7.1, manufacturer's instructions, and per drawings.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Provide engraved plastic nameplates; refer to Section 260553 for product requirements and location.

D. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.

E. The service disconnect switch must be installed on the line side of the VFD. The disconnect must be in a separate enclosure from the VFD. If conditions do not allow this disconnect to be located near the motor within NEC requirements, then a second remote disconnect may be required at the motor. Consult the project manager or University Engineer if this condition arises. All remote disconnects must be provided with auxiliary contacts hardwired to VFD safety circuit to shut down VFD when disconnect is opened. This may affect warranty on the drive so every attempt should be taken to install it per these design guidelines.

3.3 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to be present at start up and inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Prior to initial energization, provide the service of the manufacturer's field representative to prepare and start controllers.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

END OF SECTION 26 2923